# SAN DIEGO RIVER - OCEAN BEACH WATER QUALITY IMPROVEMENT PROJECT

## San Diego River Sampling and Source Identification Investigations

## Phase I - Final Report

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MEC ANALYTICAL SYSTEMS, INC.

# SAN DIEGO RIVER - OCEAN BEACH
# WATER QUALITY IMPROVEMENT PROJECT

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## Phase I - Final Report

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## Introduction

San Diego River is a prominent feature of San Diego County. From its source in the Laguna Mountains to its terminus at the Pacific Ocean near Ocean Beach, it provides an environment for many recreational uses and habitat for wildlife. The San Diego River meanders through the river-side communities such as Lakeside, Santee, Mission Valley and San Diego. Mission Trails Park, a large open space in East County and the Riverwalk Golf Course in Fashion Valley are built around the river. Just west of Interstate 5, the river becomes tidally influenced and the large flood plain comprises the Southern Wildlife Refuge. The mouth of San Diego River is located just north of Ocean Beach at Dog Beach. Dog Beach is an icon of the Community of Ocean Beach and was one of the first leash-free areas in the United States. Dog Beach is a popular tourist destination providing opportunities for surfing, swimming, sunbathing, and for pet-owners to exercise their dogs.

Despite the positive influence the San Diego River has on recreational uses and sustaining wildlife, water quality degradation has the potential to negatively impact the public and wildlife community. The City of San Diego (City) recognized the need to sustain a high level of water quality in order to maintain the river's beneficial uses. By the mid-1990's, the Mission Bay Sewage Interceptor System (MBSIS), which includes the tidally influenced portions of San Diego River, was in place and working to prevent sewage overflows and dry weather flow from impacting the region's water resources.

Although the MBSIS has proven its capabilities to prevent sewage overflows and divert urban run-off from Mission Bay and San Diego River, bacterial contamination still occurs. Bacterial contamination has been documented in the San Diego River and at Dog Beach. Based on recommendations of the Regional Water Quality Control Board (RWQCB), the Lower San Diego River is 303(d) listed as impaired for bacterial contamination. In addition, samples collected since 1999 as required under the State's AB411 criteria have exceeded standards on numerous occasions at Dog Beach.

In 2002, the City, in response to a request under the California Water Code, Section 13267 by the RWQCB, investigated bacterial contamination at Dog Beach. In spite of Best Management Practices (BMPs) established in the Summer and Fall 2001, such as the addition of signage, disposable bags and trash cans for dog owners to pick up after their pets and the relocation of the County of San Diego Department of Environmental Health's (DEH) AB411 monitoring site, the City's investigation found that bacterial contamination along Dog Beach often exceeded AB411 standards and was spatially and temporally variable. Their findings also suggested that dog and bird feces were not the primary contributors to elevated bacterial levels recorded at that beach.

Based on the numerous exceedances of the AB411 criteria and the City's investigation, the City obtained a grant from the Clean Beaches Initiative for investigation of bacterial sources potentially impacting Dog Beach. This project, San Diego River – Ocean Beach Water Quality Improvement Project, Phase 1, was designed to investigate potential sources of bacterial contamination to the San Diego River including storm drain and near beach diversion structures, as well as any natural local sources. Its aim was to also recommend BMPs to abate any potential contamination from identified sources. This study was prepared for the California State Water Resources Control Board by the City and MEC Analytical Systems, Inc. (MEC).

## Major Tasks of the Study

The goal of Phase I of the study was to identify the source of bacterial contamination to Ocean Beach, specifically at Dog Beach, establish a baseline of water quality for the San Diego River (River) and recommend BMPs to abate bacterial contamination. There were four major tasks to accomplish this goal:

- Task 1 – Determination of segments of San Diego River for Source Identification;
- Task 2 – Human Sewage Investigations;
- Task 3 – Near Beach Storm Drain and Diversion System Investigations; and
- Task 4 – Visual Observations of other potential sources of bacterial contamination.

Task 1 was completed by performing an extensive program of sampling throughout the River. Sites were located from the mouth of the River to approximately 11 miles upstream in the Mission Trails Park. Results showed that the river (Mission Trails to the San Diego River mouth) could not be considered as a whole. Bacterial concentrations varied from site to site, and this variation was consistent from day to day for the duration of the study. There appeared to be areas with a chronic source input, however, the resulting elevated bacterial levels would be undetectable at stations downstream. Samples collected at Sunset Cliffs Blvd. Bridge showed the disconnect between stations upstream and stations around Dog Beach. This station had significantly lower levels of all three bacterial indicators than the next closest upstream station, suggesting that bacterial contamination was not being transported downstream. The lower levels between these stations may be due to increased dilution, deactivation by sunlight or the natural transition to more saline water. Levels of *Enterococcus* significantly increased at stations on Dog Beach suggesting the presence of a local source.

In Task 2, potential inputs of human sewage to the river system were investigated. A review of City provided maps of the sewage infrastructure to determine likely locales of human sewage inputs along with interviews of City staff were conducted. These investigations resulted in no probable inputs from human sewage. Samples for Polymerase Chain Reaction analyses to determine the presence of human fecal contamination around Dog Beach were conducted to confirm the initial findings. These samples showed that only 1 of 18 samples may have had a weak human fecal contamination signature. The presence of non-human fecal contamination in all other samples collected suggested that there were no chronic inputs of human fecal contamination to Dog Beach. In addition, a closed-circuit TV inspection of a comfort station on Ocean Beach was conducted. The inspection found the sewage system serving this comfort station to be in good condition and not a source of bacterial contamination.

Task 3 was completed with inspections of the 7 pump stations serving the Lower San Diego River and multiple storm drain outfalls. All but one of the 7 pump stations were found to be undiverted. Pump Station H was the only station diverting flow to the sewage system during dry weather conditions. Pump Stations D, E, I , J and K all discharge to the river system, however, only Pump Station D discharges directly to the River; other pump stations discharge to wetland type habitat on the flood banks of the River. Only Pump Station D discharges significant volumes of urban runoff and this discharge impacts water quality in the River locally downstream. During the course of this study, discharge from Pump Station D did not evidently impact Dog Beach.

Of the numerous outfalls inspected, two outfalls were discovered to be inputting elevated bacterial levels that could degrade the water quality at Dog Beach. These were Outfalls 13 and 14 located at the southeastern end of Dog Beach. Samples collected at their terminus were significantly higher for all three bacterial indicators than samples collected 0.5 miles upstream. The remaining outfalls inspected were either dry or samples either had low levels of the three bacterial indicators or the discharge was not observed to impact Dog Beach.

The results of Tasks 1 – 3 suggested that the River was not the primary source of bacterial contamination to Dog Beach. Elevated bacterial levels on the beach appeared to be from local sources. Therefore, several site and time specific studies located around Dog Beach comprised the efforts to satisfy Task 4. Surveys were conducted to establish sources and transport mechanisms of bacteria around Dog Beach. These included sediment sampling, 24-hour tidal influence, focused high tide influence, kelp sampling and sand berm sampling surveys.

Sediment samples collected on the mudflats east of Dog Beach and along the eastern portion of Dog Beach had low levels of all three bacterial indicators. This single survey suggested that although some samples did have detectable levels of the bacterial indicators, the washing of bird feces did not appear to be the primary cause of extreme bacterial contamination observed along Dog Beach. This confirms earlier studies performed by the City.

Based on findings from similar studies in other regions of Southern California, a survey was developed to determine if elevated bacterial levels were related to tide height or stage (flooding vs. ebbing). Four surveys were conducted, two on neap and two on spring tides, with samples collected every two hours along Dog Beach. An upstream station was included in the survey to rule out any potential influence of the River at the same time. Although statistical analyses could not confidently (alpha = 0.05) confirm a direct relationship between tide height or stage with bacterial levels, graphical representations suggested that high tides caused an increase in bacterial levels and the presence of sunlight (UV) decreased levels.

The appearance that bacterial levels increased following high tides resulted in a study that focused sampling around the high tide. High tides tend to wash the wrack line collecting on the beach (the wrack line is composed of marine vegetation, typically kelp and eelgrass, and other debris found deposited at the extent of the last high tide). Observations on the beach showed that dog feces tend to be higher within the wrack line as well. Therefore, it seemed that the source of elevated bacteria levels may be the washing of dog feces in the wrack line. Four surveys were conducted that collected samples approximately 3-hours prior to high tide, during high tide, and approximately 3-hours following high tide. Samples were also collected in three specific regions of the beach, west (surf influenced), north (strong tidal current flow, steep beach, narrow river channel) and east (variable tidal current flow, flat beach, mudflats). The west and north regions were further segmented into areas with observed higher and lower concentrations of dog feces in the wrack line. The results showed a significant difference between pre- and during high tide samples. Samples collected at high tide were significantly higher than those collected 3 hours prior, with concentrations of all three bacterial indicators typically an order of magnitude or more greater. The western region had the lowest concentrations of bacterial indicators and samples collected in areas with high concentrations of dog feces versus areas with low concentrations of dog feces were not significantly different. This suggested washing of the wrack line itself was a contributing factor to elevated bacterial levels.

Samples of freshly deposited and decomposing kelp and eelgrass from the wrack line were then collected and analyzed. These samples were collected with and without the apparent presence of dog fecal matter. Results showed that decomposing marine vegetation, with or without the apparent presence of dog feces, had levels of bacterial contamination that were among the highest levels observed during the study at Dog Beach and the washing of this material could be the primary mechanism for transporting bacteria in high concentrations into the water column. Freshly deposited marine vegetation did not have similarly elevated levels of bacterial contamination. The source of the bacterial contamination to the marine vegetation is assumed to be dog and bird feces, however, the mechanism for bacterial transport from one pile to the next and the ability of bacteria to regrow in this environment was not studied directly.

Sand Berms are constructed along Ocean Beach, adjacent and directly south of Dog Beach, during winter months to protect back shore property. Sand berms are not constructed on Dog Beach. These sand berms are constructed with kelp as a binding agent. Ocean water samples collected prior to the sand berm spreading event in Spring 2003 were significantly lower in bacterial contamination as compared to samples collected directly after the spreading event.

## Conclusions

The tidal estuary appeared to disconnect the influence of the River from impacting Dog Beach. The decrease in bacterial levels may be a result of several factors, including increased dilution and deactivation by sunlight and more saline water. This was shown in the river segment source identification surveys as part of Task 1. Exceedances of the AB411 criteria still occurred at samples collected on Dog Beach suggesting the presence of a local source. Inspections of the storm drains and near beach diversion systems found that samples collected at the base of Outfalls 13 and 14 had significantly higher bacterial concentrations than the nearest upstream station. The exchange of water during a tidal cycle in the estuary provides the mechanism for these elevated bacterial levels to impact the shores of Dog Beach. In addition, focused studies of tidal washing effects showed that bacterial levels increase with high tides. During periods of high tides, the wrack line, consisting of decomposing marine vegetation, dog feces and likely bird feces was washed, providing a mechanism for transporting bacteria into the water column.

Samples of this wrack line were analyzed and extremely high levels of all three bacterial indicators were documented.

Based on the results presented, two major recommendations are made. The first is to redesign the infrastructure at Outfalls 13 and 14. Increasing the diversion capacity and eliminating effects tidal intrusion in the storm drain outfalls appears to be a priority in reducing beach closures at Dog Beach. Second, wrack line, or “kelp” management practices need reviewing. Best Management Practices to consider would be the removal from the site of deposited marine vegetation and the reduction of kelp used as a binding agent in sand berms, where at all feasible, taking into consideration the risk of flooding and the protection of public safety and property.

# Introduction

## 1.1 Project Scope

San Diego River is a major geographic feature of San Diego County. Its course through the Cleveland National Forest and many river-side communities, including Lakeside, Santee, Mission Valley and San Diego provides a variety of recreational and industrial uses. The San Diego River provides habitat for wildlife in an urban surrounding. The terminus of the San Diego River is the northern boundary of Ocean Beach where it discharges to the Pacific Ocean. Dog Beach, at the mouth of the River, supports an environment conducive to surfers, beach-goers and dog-owners with their pets.

In the 1980's, the City of San Diego recognized the beneficial uses of the river and adjacent Mission Bay were being impaired due to sewage spills, overflows and urban runoff. As a result, the Mission Bay Sewage Interceptor System (MBSIS) was designed and construction finished in the mid-1990's. This system, originally designed to divert sewage spills and overflows, diverts dry weather urban runoff from many of the outfalls to the River.

Despite water quality improvements as a result of the MBSIS, water quality monitoring of the San Diego River indicates that bacterial contamination is still a frequent and persistent problem. First, based on recommendations from the Regional Water Quality Control Board (RWQCB) the Lower San Diego River was 303(d) listed as impaired for bacterial contamination. Second, the State's AB411 criteria have been exceeded numerous times at the mouth of San Diego River. Dog Beach has been among the most frequently posted sites for bacterial standard exceedances in the County and was posted for contamination warnings a total of 123 days in 2000. Bacterial counts at adjacent Ocean Beach have also been high. In 2000, Ocean Beach was posted for contamination warnings a total of 127 days. Potential sources of contamination were urban runoff, sewage spills and/or other non-point sources.

In August 2001, the RWQCB issued a California Water Code, Section 13267 letter requesting an investigation of contamination at Dog Beach. In response to the San Diego River Mouth Technical 13267 Reporting Requirements, the City of San Diego (City), RWQCB and County of San Diego Department of Environmental Health (DEH) developed a one-month sampling plan to confirm trends in bacterial levels at Dog Beach. This study was conducted in January and February 2002 and although historical data suggested a declining trend in levels, study results showed that bacterial contamination continued to impact water quality. However, the study results also indicated temporal and spatial variability in bacterial contamination at Dog Beach. The report concluded that a sewage spill at the beginning of the study may have impacted Dog Beach and water quality degradation from bird and dog fecal matter appeared to be minimal.

During this same timeframe, other actions were taken. The AB411 monitoring site on Dog Beach was moved to a location that represented a beach with surf zone mixing instead of estuarine conditions. The City implemented several Best Management Practices (BMPs) to reduce bacterial sources of fecal contamination. Additional signage, disposable bags and trash cans were provided for dog owners to remove the most obvious source of bacterial contamination, dog feces, from the beach. The City also increased patrols of the beach area to enforce the City's Municipal Codes.

In 2002, there appeared to be a declining trend in bacterial contamination, whether in response to the above BMPs or other factors. As a result of the City's 2001 study mentioned above, the source of contamination was assumed to be local to Dog Beach, with bird and dog feces the primary sources. Surveys conducted in early 2002 concluded that 99% of bird feces were located in the eastern most portion of the beach, potentially only affecting one site. Dog feces were minimal (only three piles observed during the study) and not expected to be the primary cause of bacterial contamination. Though the assumed sources were not present, bacterial contamination during this study still exceeded standards based on AB411 criteria.

The frequent beach postings and closures that occurred in 1999 and 2000 throughout San Diego prompted the Mayor of San Diego to set a goal to reduce beach posting and closure days by 50% by 2004. The Clean Water Task Force was created to realize this goal. The City was able to secure grant funding from the State of California Water Resources Control Board's Clean Beaches Initiative for several bacterial source identification projects focused on Mission Bay and San Diego River. This is one of those projects: San Diego River – Ocean Beach Water Quality Improvement Project, Phase I.

The project design of the San Diego River-Ocean Beach Water Quality Improvement Project, Phase I included an initial focus on the San Diego River and assumed that local sources (bird and dog feces) were not the primary cause of bacterial contamination at Dog Beach. The study sought to identify any potential infrastructure (either sanitary sewer or storm drain systems), urban runoff and anthropogenic patterns that may be the primary causes of the observed water quality degradation. Based on limited historical upstream monitoring results of bacterial contamination within San Diego River, the study design assumed the River may be transporting this bacterial load downstream and causing beach closures at Dog Beach and Ocean Beach.

This project was initially designed to satisfy these assumptions and identify potential sources throughout the River. The River Segment Source Identification Surveys, discussed in Section 2.1, were conducted to identify specific segments of the River having elevated bacterial levels and follow-up with source identifications. The Near Beach Diversion System Surveys (Section 2.2) were conducted to determine the effectiveness of the diversion system. These surveys, often referred to as initial investigations throughout this report, provided results suggesting that upstream reaches of the River (i.e. east of Sunset Cliffs Blvd. Bridge) are not a source of bacterial contamination at Dog Beach. Therefore, the project was refocused to re-examine local sources. Section 2.3 describes the studies that were subsequently designed to identify potential local sources and mechanisms of transport.

The project's fundamental goal is to reduce beach postings and closures based on AB411 criteria at Ocean Beach and specifically, Dog Beach. The Phase I goals of the project are:

1. Investigate the potential sources of bacterial contamination along the San Diego River;
2. Establish a water quality baseline against which to measure BMP effectiveness; and
3. Recommend actions, including BMPs, based upon source investigation to abate bacterial contamination in the San Diego River.

## 1.2 Project Area

The San Diego River (River) watershed is a major hydrologic unit in San Diego County, draining sub-basins from the Laguna Mountains to the Pacific Ocean (Figure 1-1). The watershed encompasses approximately 277,500 acres and includes diverse land uses including residential, commercial, industrial, and agricultural areas.

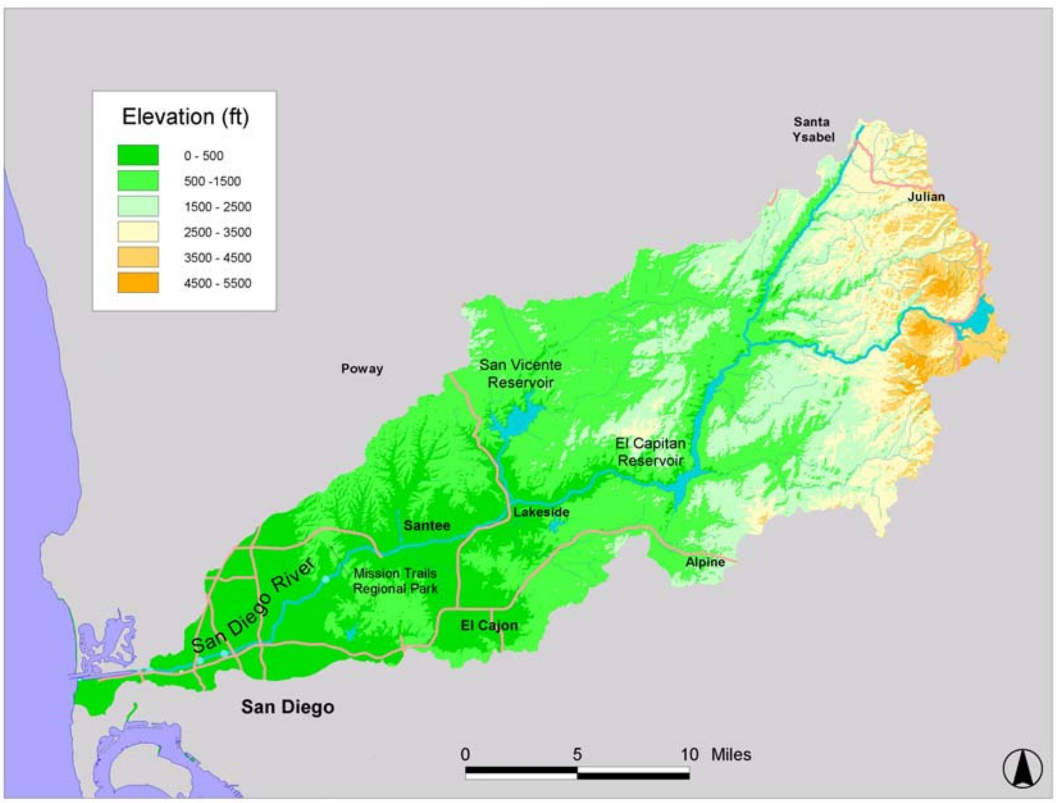



**Figure 1-1. San Diego River Watershed.**

The Lower San Diego River (Figure 1-2) comprises the area from the mouth of the River to Mission Trails Park, an open park (green space) approximately 11 miles upstream. The Lower San Diego River is the focus area of this study. This portion of the River flows through the residential and commercial communities of Mission Valley and Fashion Valley, Riverwalk Golf Course and the Southern Wildlife Refuge in the estuary west of Interstate-5.

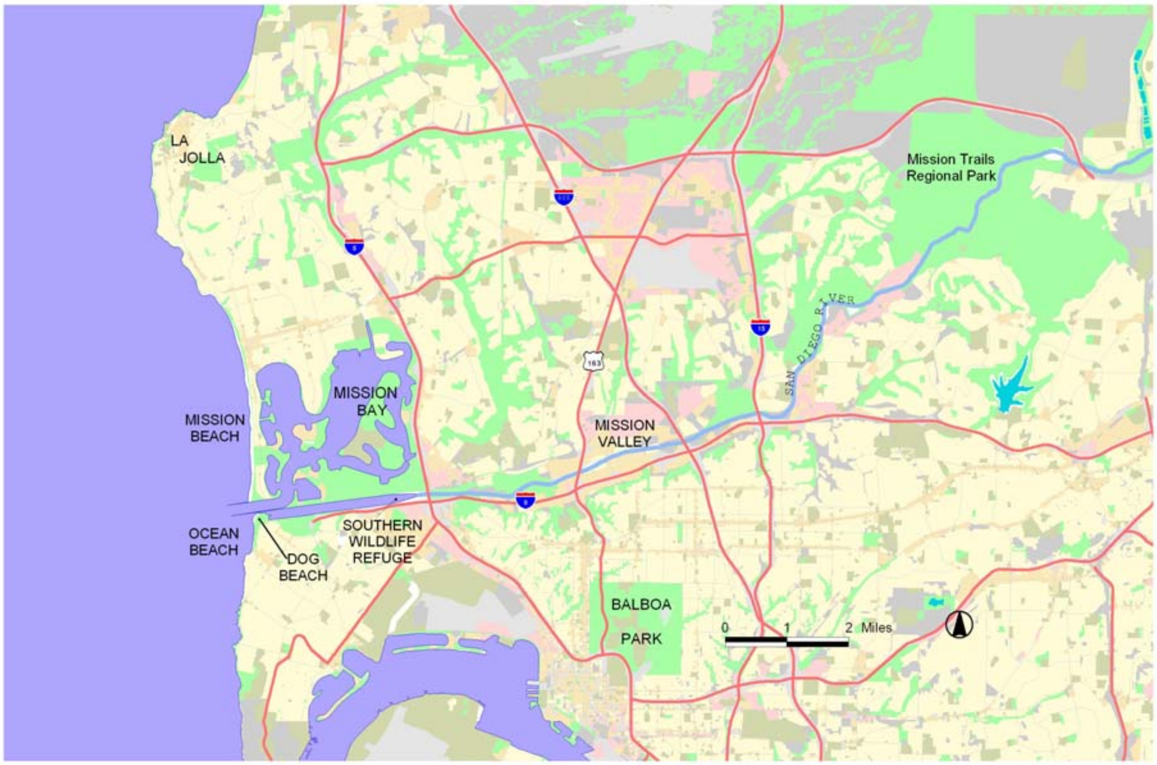



**Figure 1-2. Project study area – Lower San Diego River.**

The River discharges into the Pacific Ocean on the northern boundary of Ocean Beach. Ocean Beach is an important tourist destination and a popular recreational beach in San Diego County for swimming, surfing, and other water contact activities.

The predominant ocean current in this area flows southward along the coast. Thus, the discharge from San Diego River (mean of 15.6 cubic feet per second) is transported from the River mouth south toward Ocean Beach and beyond. Weaker and episodic currents may also carry the River's discharge north toward Mission Beach.

## 1.3 History of AB411 Criteria

Assembly Bill 411, also known as "The Right to Know Bill", was sponsored by Assemblyman Howard Wayne and was enacted in October of 1997. The Bill requires that for the months of April through October, weekly bacterial monitoring be performed at all beaches with more than 50,000 annual visitors and at beaches adjacent to storm drains with summer flow. Any beaches found to exceed the bacterial limits enforced by the Bill are posted with warning signs to notify the public of potential health risks. Despite common belief, the bacterial limits that have come to be known as AB411 were in effect years before the Bill was passed. AB411 was created to update and enforce bacteriological safety standards set forth in the California Code of

Regulations, Section 115880. This Bill provides a regulatory framework by which the numerical limits can be enforced. Each of the limits set forth by the California Department of Health Services (the Department) for total and fecal coliforms and *Enterococcus* were derived separately over the past several decades and are discussed here individually.

**Total Coliforms.** Total coliforms have been the basis for determining water quality for over a century. Coliform bacteria was the first family of organisms used in epidemiological studies to determine the effects of contaminated water on the health of recreational bathers. In the 1940s and 1950s, the U.S. Public Health Service performed epidemiological studies on bathers of the fresh and saltwater bodies of Lake Michigan, the Ohio River, and Long Island Sound. The most significant of these was the Ohio River study. This study compared illness observed in bathers exposed to water after three days of high coliform density counts to those exposed after three days of low coliform density counts. The study found that significantly higher illness rates occurred when water contained a geometric mean of 2,300 coliforms per 100 mL, as compared to 43 coliforms per 100 mL. No increase in illness rates was observed when differences in geometric means of 732 versus 32 coliforms per 100 mL were present. Two additional marine bathing beach studies showed no association between illness and swimming in water containing up to 815 coliforms per 100 mL.

In 1986 the U.S. Environmental Protection Agency (EPA) summarized the above results, and found that a 30-day geometric mean of 1,000 coliforms per 100 mL was an acceptable level for recreational water safety. In addition, an instantaneous maximum of 10,000 coliforms was set as the single sample standard. In an epidemiological study of 15,000 swimmers in Santa Monica Bay, this 'instantaneous maximum' was determined to be reasonable. Researchers found that exposures at levels greater than the 10,000 coliform limit resulted in a 200% increase in certain health risks, supporting the EPA 10,000 coliform limit.

**Fecal Coliforms.** AB411 regulations include a single sample standard of 400 fecal coliforms per 100 mL and a 30-day geometric mean of 200 fecal coliforms per 100 mL. These numeric standards were based on the Ohio River study previously mentioned. In this study, it was determined that approximately 18% of the total coliforms found in the Ohio River were of the fecal coliform group. As discussed above, the U.S. EPA summary of total coliforms found a limit of 2,300 total coliforms to be the point in which illness was significantly increased. Interestingly, the limit of 400 fecal coliforms per 100 mL was generated by simply multiplying the 2,300 total coliform number by 18%. However, the National Technical Advisory Committee of the Department of the Interior was authorized to make recommendations regarding the safety of recreational waters and argued that a detectable increase in disease was not acceptable. Therefore, the 400 fecal coliform limit was cut in half to 200 in order to determine the 30-day geometric mean. The Santa Monica Bay study of 1996 found the 400 fecal coliform limit to be reasonable. It was found that exposures to levels greater than 400 total coliforms were related to an 88% increase in the risk of skin rashes. Both the total and fecal coliform limits expressed above are consistent with the State Water Resources Control Board's California Ocean Plan (1997) used today.

***Enterococcus.*** The AB411 standards for *Enterococcus* include a single sample standard of 104 *Enterococcus* per 100 mL, with a 30-day average mean of 35. In the 1970s, the U.S. EPA performed epidemiological studies involving 27,000 people at several beaches in New York, Louisiana and Massachusetts (Cabelli 1983). The investigators found that *Enterococcus* was the best of the 3 indicator organisms for the prediction of human illness associated with recreational waters (gastrointestinal illnesses were related to *Enterococcus* numbers by correlation coefficients of 0.75 to 0.96, compared to 0.12 to 0.46 for total coliforms and 0.01 to 0.51 for fecal coliforms). The study was used by the EPA in 1986 to estimate that swimmers exposed to *Enterococcus* in water at levels of 104 MPN/100 mL (or 35 MPN/100 mL for the 30-day mean) would result in 19 cases of gastrointestinal illness or other effects per 1,000 people exposed. In 1986, these limits were entered in the U.S. EPA Ambient Water Quality Criteria for Bacteria Guidance. Additionally, the California Ocean Plan requires monitoring for *Enterococcus* and requires investigation if a discharger is responsible for the contamination when the 30-day geometric mean exceeds 24 MPN per 100 mL (or 12 per 100 mL for a six-month period).

In 1996, the Santa Monica Bay study found that when instantaneous *Enterococcus* maximum limits were exceeded (the study used 106 as the limit, versus 104), an increase of 323% in diarrhea with blood and a 44% increase in vomiting and fever was observed in exposed swimmers.

As can be seen, the bacterial limits for overall recreational water quality enforced by AB411 have been developed over the past 5 decades. What continues to change and improve with time is the enforcement of these limits. In 2000, Assemblyman Howard Wayne created AB1946 as a follow-on bill to AB411. This Bill improves on requirements for data collection and public notification. As of January 1, 2001, this Bill requires the state to collect more accurate information on the actions taken at beaches found to be contaminated (i.e. postings). The Bill requires the State Water Resources Control Board to post beach data from throughout the state on a monthly basis. In addition, every June the Board compiles all data into an annual report, which is made available on the Board's website. The AB411 criteria for California are presented in Table 1-1.

**Table 1-1. Assembly Bill 411 (AB411) bacteriological standards.**

| | 30-Day Limit[1] | Single Sample Limit |
|---|---|---|
| Total Coliform | 1,000 MPN/ 100 mL[2] | 1,000 MPN/ 100 mL if Fecal > 10% of Total, or 10,000 MPN/100 mL[3] |
| Fecal Coliform | 200 MPN/ 100 mL | 400 MPN/ 100 mL |
| *Enterococcus* | 35 MPN/ 100 mL | 104 MPN/ 100 mL |

1 = 30 day limit is based on the geometric mean of at least five weekly samples
2 = MPN is Most Probable Number
3 = Total coliform single sample limit of 10,000 MPN drops to 1,000 when the fecal coliform value is greater then 10% of total coliform value

Note: AB411 standards only relate to coastal recreational beaches. The goal of this project was to reduce beach closures based on AB411 criteria at Dog Beach and Ocean Beach. Therefore, throughout this study and as presented within this report, all sample results, including those from samples collected within the River, were compared to AB411 criteria.

## 1.4 History of the Sewage Interceptor System

The Mission Bay Sewage Interceptor System (MBSIS) was originally conceived in the 1980's to reduce the impact of sewage spills and overflows to Mission Bay and the San Diego River Channel. The water quality in Mission Bay was poor and resulted in beach postings and closures through the 1980's and early 1990 as a result of sewage spills and overflows. In 1987, Hirsch and Company prepared the Final Master Plan for the MBSIS (Phase II) to develop a *ring of protection* around Mission Bay and the San Diego River Channel with the intent of eliminating the impact of sewage spills.

The first step of the Master Plan was to prioritize the storm drains in Mission Bay and San Diego River relative to their potential for carrying human sewage to the receiving waters. The criteria used for this prioritization included the size of the storm drain, whether it was an outlet for a sanitary sewage pump station, its proximity to a trunk sewer, and its potential for collecting sewage spills. Based on the prioritization, 23 storm drains were ranked with a priority of 0 indicting that they had no sewage spill potential. Eight of the 23 storm drains discharge to San Diego River.

It is important to note that potential sources of bacteria other than human sewage (e.g., urban runoff, bird fecal matter, etc.) were not included in this prioritization. These storm drains were subsequently removed from the Master Plan and are not part of the current MBSIS. In addition, there are several storm drains that were identified during this study that are not discussed in the Master Plan and are not included in other City storm drain maps. Although the potential for these storm drains to convey human sewage to the River was considered low in the Master Plan and are therefore un-diverted, they can convey bacteria from other sources, such as bird waste or urban runoff from areas surrounding San Diego River.

By 1995, the MBSIS was constructed with design and operational conditions documented by Corrao-Brady Group and Hirsh & Co. in the MBSIS Field Handbook (February 1995). As a result, six outfalls to San Diego River now benefit from interceptor pump systems or valves.

It is important to recognize that fifteen years ago the purpose of the MBSIS was primarily to intercept sewage and minimize its impact on the receiving waters. In 2003, the system is viewed not only as a sewage interception system, but provides the ability to divert urban runoff from Mission Bay and the San Diego River Channel. The expanded use of the system recognizes: 1) the system has a positive role in reducing beach postings and closures, including urban runoff that may have elevated levels of bacteria and other pollutants; and 2) regulatory and political pressure to continue to improve water quality beyond expectation set in the 1980's (sewage spill control) to increasing focus on urban runoff in 2001 as presented in Municipal Separate Storm Sewer System NPDES Order 2001-01.

# Project Approach

This project was divided into the following five tasks:

1. Determination of segments of San Diego River for Source Identifications;
2. Human Sewage Investigations;
3. Near Beach Storm Drain Diversion System Investigations;
4. Visual Observations of other potential sources of bacterial contamination; and
5. Reporting of survey results and recommendations.

These tasks have been satisfied with the completion of the following surveys. The initial River Segment Source Identification Surveys and Chronic Input Investigation surveys satisfy Task 1. Task 2 was satisfied by reviewing maps of the sewage system, conducting closed-circuit TV of comfort stations, interviewing City personnel and collecting samples for Polymerase Chain Reaction analyses to determine the presence or absence of human fecal contamination. The Storm Drain and Diversion Systems were investigated and samples collected as necessary to complete Task 3. Task 4 was satisfied with the completion of focused studies along Dog Beach and Ocean Beach to determine potential localized sources of bacterial contamination. The submission of this report completes Task 5.

## 2.1 River Segment Source Identification Surveys

The objective of these investigations was to prioritize River segments by level of contamination followed by source identification and BMP recommendations. To complete that objective, the surveys had the following tasks:

1. Conduct monitoring of bacterial levels at six transects along the San Diego River to identify River segments with more concentrated bacterial levels.
2. Conduct basic field observations at all transect sampling locations.
3. Identify River segments with more concentrated bacterial levels and conduct a more intensive source investigation (includes extensive review of maps for potential sources, additional River transect monitoring, and field investigations).

These surveys were first conducted in October 2002. The resulting data showed that there was not a major chronic input of bacterial contamination to the River and that the low levels of bacterial contamination that was observed did not appear to be directly impacting Dog Beach.

To confirm observations and assumptions developed during the initial river segment source identification surveys performed in October 2002, a systematic sampling program was designed to determine if there was a chronic source of elevated bacterial concentrations in the River. Further, it set out to determine if the River is a contributing source to elevated bacterial concentrations observed at Dog Beach. Similar to the initial investigations, these surveys were designed to identify potential point sources or subsegments with relatively higher concentrations of bacteria.

A temporal matrix was developed to answer the question of chronic inputs by collecting samples at various days and time. Twenty-seven chronic input investigation surveys were conducted during the 2003 dry weather season (April – August 2003). The days of the week were arranged into three groups (Mon/Tue, Wed/Thu/Fri, and Sat/Sun) and each grouping was divided into 3 periods (Day – 06:00 to14:00, Evening – 14:00 to 22:00 and Night – 22:00 to 06:00). Sampling during each of these times (i.e. Saturday or Sunday at Night) was performed on three separate occasions. This sampling scheme was necessary in order to confidently determine if any potential chronic inputs were occurring.

Results from the initial river segment source and chronic input investigation surveys that are relevant to the entire project area are presented in Section 3. More detailed site by site results are presented in Sections 5 – 10.

## 2.2 Near Beach Diversion Systems

The Lower San Diego River has seven pump stations to divert storm drain flow to the sanitary sewer system. This diversion reduces the amount of urban runoff and storm water that enters the River. The effectiveness of these diversion systems were determined by:

1. Reviewing map of diversion systems and pump stations and field verifying map accuracy.
2. Reviewing maintenance history of diversion system, including inspections and removal of debris.
3. Collecting samples upstream, downstream and at the site immediately prior to and during the investigation for bacterial analyses of total and fecal coliforms and *Enterococcus*.

On-site investigations of the pump stations occurred in a series of visits on November 25 and December 2, 2002; January 2, January 27 and May 19, 2003.

## 2.3 Development of Local Source Identification Surveys

The purpose of initial investigations described above were to determine if any segment of the River had consistently higher levels of bacterial contamination and if so, perform source identification surveys to locate the possible sources. Additionally, surveys of the Near Beach Diversion System (Pump Stations) were performed to determine potential bacterial loads being contributed to the River from this infrastructure. The results of these initial investigations conducted in Fall 2002 and Winter 2003 suggested that there was no obvious area in the River that was acting as a chronic source of bacteria that is conveyed to area beaches.

The typical dry weather conditions present during these investigations appear to minimize (by dilution, die-off, etc.) the transport of bacteria from the freshwater riverine environment to the downstream marine coastal environment. This is not the case for extreme conditions such as large sewage spills in the River. The increased loads of total suspended solids (TSS), floatables, organics and associated bacterial concentrations during sewage spills appear to favor the survival of bacteria over the normal environmental conditions in which sunlight and saltwater act as a bactericide. A discussion of historical data including sewage spills is presented in Section 3.

The apparent discontinuity in bacterial concentrations between the upstream locations and the coastal beaches led to the need to focus the investigation on several local sources. These sources include discharge from Outfalls 13 and 14, bacterial loading from shorebirds in beach and mudflat sediments and bacterial loading from dogs in the high tide wrack line. Additionally, mechanisms for transporting bacteria into the water column were studied such as the relationship of bacterial concentrations to tidal heights and cycles. These potential sources were investigated through a series of studies. A brief explanation of each of these studies is provided below.

### *2.3.1 Literature Review*

A literature review was undertaken to provide insight into potential sources of bacterial contamination (and mechanisms of transport or die-off and regrowth) to coastal beaches in other communities. A discussion of findings relevant to the Lower San Diego River, Ocean Beach and Dog Beach is presented in Section 3.

### *2.3.2 Historical Data Analysis*

Existing data was analyzed to determine potential trends of closures with factors such as long and short term tidal periods, river flow, beach operations and management, and sewage spills. Data were provided by the City of San Diego and regulatory agencies for bacteria concentrations at AB411 sampling sites in Mission Beach, Ocean Beach, and Dog Beach as well as for sewage spills. A detailed discussion of the historical data analysis is presented in Section 3.

### *2.3.3 Storm Drain Outfall/Diversion System Infrastructure Surveys*

Storm drains and the diversion structures continued to be surveyed during the course of the project. Throughout the River, outfalls were investigated to determine if there were any potential sources from urban runoff. Outfalls 13 and 14, located at the southeastern portion of Dog Beach, were of specific interest and were included in the chronic input surveys. An investigation into the potential contribution of bacterial contamination from two large force sewer mains in the vicinity of Dog Beach was also conducted using Polymerase Chain Reaction (PCR) analyses of the bacteriodes collected in the water sample. PCR was utilized to provide an indication of the presence of human fecal contamination based on the methods of Bernhard and Field (2000). Results of the storm drain outfall and near beach diversion structures investigations are presented in Sections 5 - 10.

### 2.3.4 Sediment Sampling Surveys

There are extensive mudflats to the east of Dog Beach that provide excellent foraging habitat for shorebirds. Sediment from this area was assessed to determine potential contributions of bacterial contamination from bird fecal matter. Sediment samples from the mudflats and along Dog Beach were collected. These results are discussed in Section 9.

### 2.3.5 Tidal Influence (24-Hour Sampling) Surveys

Tidal influence was evaluated to understand the possible effects that tidal heights and tidal cycles (neap vs. spring) may have on observed bacterial concentrations in the water. Samples were collected every 2 hours at 3 stations across Dog Beach and every 4 hours at upstream stations located at Sunset Cliffs Blvd. Bridge and Outfalls 13 and 14. Upstream stations were sampled to confirm whether bacterial contamination was localized to Dog Beach or if it was being conveyed from another source. Results from this study were used to design more focused studies aimed at understanding the contributions of specific sources or transport mechanisms. Section 9 discusses the affects of tidal influence on bacterial concentrations.

### 2.3.6 High Tide Washing Surveys

The High Tide Washing Surveys were designed to collect a series of samples at times prior to, during, and after the wrack line washing during high tides. Sample locations were adaptive to represent areas of higher concentrations of kelp and eelgrass and/or dog feces. This study was developed following results of the Tidal Influence Surveys suggested that bacterial concentrations were correlated to high tides. Results from this study are also presented in Section 9.

### 2.3.7 Kelp Sampling Surveys

The High Tide Washing Surveys indicated that tidal washing of the wrack line was negatively impacting water quality around Dog Beach. Samples of kelp and eelgrass were assessed to determine their potential as an indirect source of bacterial contamination. Section 9 details the results from these kelp sampling surveys.

### 2.3.8 Sand Berm Spreading Surveys

Operations and Maintenance procedures for local area beaches provides for the construction of sand berms (typically mixed with decomposing kelp as a binding agent) to prevent erosion of back beach areas during winter months. Ocean Beach and Mission Beach are two sites that sand berm construction is performed. Samples were collected prior to, during and after spreading events to determine if this practice leads to increased bacterial contamination in the water. Section 10 presents the results from these surveys.

# Background and Historical Data

This section presents a discussion of the findings from the literature review pertinent to the San Diego River and provides a background of historical data collected by the County of San Diego. The literature review was conducted to assist in understanding potential sources of bacteria and transport mechanisms in order to achieve the Phase I goal of identifying sources of bacteria and appropriate management action for abatement.

## 3.1 Literature Review

There are a large number of studies that have been performed in recent years assessing sources and transport mechanisms of bacteria in coastal recreational waters. Some of these studies are relevant to this project and were instrumental in the approach and design of the water quality studies undertaken in San Diego River and Dog Beach.

Determining the sources of bacteria in a watershed or water body is difficult and complex because of the transient nature of point and non-point sources of pollution (wildlife, human sewage, other anthropogenic sources, etc.), environmental interactions, the partitioning of bacteria within the environment, the transport of bacteria in the water body and the lifecycle of bacteria itself.

Among the most significant findings in the limited literature review conducted for this project we have:

- The Effects of Sunlight on Bacteria Levels
- Kelp as a Growth Medium for Bacteria
- Tidal Cycles as a Bacteria Transport Mechanism

Although the studies cited below provide clues to the numerous potential sources and mechanisms for bacteria to impact water quality in coastal waters and rivers, they also suggest that identifying those sources is complicated and site specific. San Diego River and the mouth of the River at Dog Beach located in an urban environment, present all the potential challenges faced in identifying the source of bacteria in a complex water body in Southern California and across the country.

### 3.1.1 Effects of Sunlight on Bacteria Levels

The effect of sunlight on bacteria and other pathogens has been studied extensively in the last twenty years. A study performed by Fujioka et al. (1981) compared fecal coliforms and fecal streptococci (*Enterococcus*) survival under controlled conditions in which sewage (diluted 1:1000 in seawater) was exposed to and devoid of sunlight. The time required for 90% of the bacterial population to be inactivated under specific experimental conditions was measured ($T_{90}$). Fujioka found that fecal coliforms survived between 21 and 48 hours without sunlight, but only 30 to 90 minutes with exposure. Similarly, it was found that fecal streptococcus survival was approximately 36 to 84 hours without sunlight, versus 60 to 180 minutes with exposure.

Bactericidal effects of sunlight through cloud cover were also studied. Under heavy cloud cover, fecal coliform die-off rates in seawater were similar to those from exposure to direct sunlight. Fecal streptococcus was found to be far less effected by indirect sources however. Additional studies were performed on the effects of sunlight through the water column. A drop-off 99.9% of both fecal coliforms and fecal streptococcus was observed as far down as 3.3m in clear seawater. These studies suggest that the bactericidal effect of sunlight may be due to its penetrating visible light spectrum and is not restricted to its ultraviolet light spectrum.

The seawater experiments discussed above were also performed in phosphate buffered water. In dark conditions, the study bacteria survived 1 to 3 days in saltwater, but up to 4 days in phosphate buffered water. In sunlight however, drop-off rates of bacteria were similar in both environments, suggesting “the high salt content and stressful environment of seawater is not a requirement for the inactivation of bacteria by sunlight” (Fujioka et al., 1981). These studies therefore indicate that although saltwater increases the die-off rate of bacteria, sunlight inactivation has a more rapid and detrimental effect overall.

A similar study by Sinton et al. (2002) supports the earlier findings by Fujioka. Sinton’s research includes fecal coliform, *E. coli*, *Enterococcus* and phages and focuses on ranking the inactivation rates for each. Various optical filters were used to determine which wavelengths cause the inactivation and speculate on the type of damage to the organisms.

Sinton’s study found that overall *Enterococcus* was inactivated more rapidly than fecal coliform in summertime. However, in the winter the rate of inactivation was approximately the same for all organisms tested. When simulated estuary water and seawater were compared, inactivation by sunlight was found to increase with increasing salinity, though *Enterococcus* was the least affected. Lastly, *Enterococcus* was observed to be inactivated over a wide range of wavelengths, suggesting photooxidative damage, while fecal coliforms were mainly affected by the shorter UV-B wavelengths which leads to photobiological damage and hence their greater resistance to sunlight in natural waters.

In a two-day experiment conducted in summer and winter over 32 hours under clear-sky conditions, researchers found that the longer summer light period (by approximately 3 hours) led to an increase in insolation of 4.6 times. Consistent with previous findings, fecal coliform levels were reduced by 4 orders of magnitude in summer when compared to winter. As expected, these experiments also showed a slowing of the inactivation rate of fecal coliforms and *Enterococcus* during the dark period in both summer and winter.

Lastly, in the summer, *Enterococcus* percent survival was shown to be approximately 1% after only 5 hours of insolation (exposure to sunlight) and less than 1/10 of 1% after 7 hours. Under the same conditions, fecal coliform after 5 hours remained at a 20% survival, and took 29 hours of exposure to reach the same 1/10 of 1% survival as *Enterococcus*.

An earlier study performed by Sinton (1999) compared the different interacting factors affecting the survival of fecal indicator bacteria in seawater, and found that out of nutrient availability, salinity, temperature, pH, microbial predation, and solar radiation, the latter was the most significant. The UV-B portion of the solar spectrum appeared to be the most bactericidal according to Sinton in 1994, which he later confirmed in 2001.

Recently, Sinton (2002) noted that increasing salinity had a lesser effect on sunlight inactivation rates for *Enterococcus* confirming the earlier mentioned studies by Fujioka. Also, Boehm (2002) confirmed that the concentration of indicator bacteria peaked in the middle of the night, and was lower midday when solar radiation was at its maximum. A laboratory experiment provided results indicating that samples of the same water subjected to sunlight had bactericide effects compared to samples in the dark which maintained the same levels.

### *3.1.2 Kelp as a Growth Medium for Bacteria*

The significance of kelp or seaweed as a growth medium for bacteria has been explored in New Zealand and in Southern California with similar results. The high incidence of kelp on Dog Beach (discussed in Section 8) and the use of kelp as a "binding" agent in sand berm construction on Ocean Beach (See Section 9) presents the need for identifying it as a potential contribution to water quality degradation.

Anderson (Anderson et al., 1997) notes that *Enterococcus* and fecal coliforms were recorded in decaying seaweed from recreational beaches in New Zealand with numbers being higher in the summer than winter. The research found ratios of fecal coliform and *Enterococcus* on kelp versus seawater to be 267 to 1 and 967 to 1, respectively. Similar measurements were conducted for seaweed versus sand from areas adjacent to degrading seaweed with results as high as 3,467 to 1. "The elevated levels in seaweed indicate possible expansion in the growth-permissive environment" notes Anderson. Samples of *Enterococcus* were taken from seaweed, sand and seawater and characterized by restriction enzyme analysis techniques. Genetically identical (clonal) populations dominated seaweed profiles, sand isolates were more variable with only 2 repeats out of 10 profiles, and water isolates were all unique with no comparisons to seaweed or sand. According to Anderson, "the presence of clonal *Enterococcus* populations in decaying seaweed strongly suggests that active replication or selection is occurring within this medium" and "the mixture of *Enterococcus* genotypes found in sand and water suggests that the bacteria are derived or accumulated not only from the seaweed but also from other sources (e.g. direct fecal contamination and runoff)". Earlier work by Geldreich et al. (1964) points out that the presence of *Enterococcus* on plant material may be due to direct contamination by animals and insects.

Seaweed and especially decaying seaweed associated *Enterococcus* will produce positive results in routine water quality analyses even when direct sources (human and/or animal) have not been recently present and could be transported to decaying kelp by insects (flies). Therefore, the potential exists for *Enterococcus* to be introduced to adjacent waters from seaweed by re-suspension or wash-off effects of tides.

A study conducted by Grant et al. (2001) in a coastal saltwater marsh in Southern California found that 19% of marsh sediment samples (n=96) were positive for *Enterococcus* compared to 2% (n=121) of sediment samples in the surf zone. The results of vertical profiles of sediment from the marsh also showed that 65% of the surface sediment (top 1 cm) was positive for *Enterococcus*. In addition, *Enterococcus* levels as high as 4,500 MPN/g in seaweed in the marsh suggested that *Enterococcus* were living and potentially growing in the seaweed in the marsh. The study also concluded that *Enterococcus* bacteria generated in the tidal saltwater marsh located near the beach initially impacted surf zone water quality during ebbing tides, but under most conditions decreased due to a dilution effect in the surf zone and die-off in ocean waters.

### *3.1.3 Tidal Cycles as a Bacterial Transport Mechanism*

Transportation of bacteria from one site or medium to another can often complicate attempts to identify the specific source. Tidal mechanisms are an important variable in the study of natural environments especially for bacteria.

The paper discussed in the previous section by Grant et al. (2001) found that in a coastal saltwater marsh being studied, *Enterococcus* levels just downstream of the marsh doubled during the ebb tide as compared to a flood tide.

Boehm et al. (2002) found in a 24-hour study at two sites a bacterial signal that followed a semi-diurnal pattern, with the highest concentration occurring during the falling tides. In 2002, Boehm noted that lunar variability patterns suggested an underlying mechanism for delivery and mixing of pollutants in the coastal ocean. Furthermore, total and fecal coliform and *Enterococcus* levels peaked shortly before the new moon spring tide and again around the full moon spring tide.

A tidally influenced coastal river was studied by Solo-Gabriele et al. (2000) where *E. coli* concentrations increased with high-tide levels. The authors speculated that growth occurred in the soils during low tide and increasing tide levels provided a mechanism for bacterial transport to the water column.

By drying and storing contaminated sediments and later testing them for growth, laboratory experiments later confirmed that sediment supported the growth of indicator bacteria. Transport to the water column was confirmed when the experimental sediments were submerged in water. The water column showed increased *E. coli* and other fecal coliform counts.

## *3.2 Historical Data*

Historical data were obtained from the City of San Diego and several regulatory agencies, and were analyzed to discern patterns in the levels of bacterial contamination at Dog Beach (and other beaches). AB411 monitoring data from January 1999 - June 2003 were obtained from the

County of San Diego's Environmental Health Department. Sewage spill data were made available from the San Diego Regional Water Quality Control Board. River flow volumes were obtained for the USGS gauge at Fashion Valley. The City of San Diego provided additional monitoring data and reports for Dog Beach and Ocean Beach.

The datasets were assembled and subsequently used to answer the following questions:

1. Are there any discernable patterns in the bacteria levels at Dog Beach compared to Ocean Beach and Mission Beach?
2. Can a tidally influenced pattern in bacteria levels be identified?

The only readily discernable patterns that emerged from the historical dataset were elevated bacterial concentrations following some of the larger sewage spills and also after storms as represented by increased river flow. The data sets are presented in Appendix B.

Due to the magnitude of the dataset, tidally influenced patterns were not obvious. To determine whether there was a tidally influenced pattern in bacteria levels an analysis of variance (ANOVA; a method of analyzing dataset variances in order to test a hypothesis about the means of datasets) was used to statistically test for differences between increased bacterial concentrations and tidal levels. Because the actual time of sampling was unknown, the lunar cycle was used as a surrogate for tide as suggested by the results in Boehm et al. (2002). This approach separated the data into two categories: spring tide with large tidal differences and neap tide with flatter tides. Because of the patterns observed with increased river flow and sewage spills, data collected within five days following a sewage spill into the river or stream flow above ambient conditions (50 cfs) were excluded from the analyses. The results of the ANOVA showed that total and fecal coliform concentrations were significantly higher during spring tides than neap tides. *Enterococcus* concentrations were also higher in concentration during spring tides, however, the difference relative to neap tides was not statistically significant.

The data from Dog Beach were also compared to data from Ocean Beach and Mission Beach. For the four years of historical data provided (1999 – 2002), Dog Beach consistently had a high frequency of samples exceeding AB411 standards (Table 3-1). Despite the frequency of these exceedances, samples collected at Dog Beach have steadily dropped since 1999. Ocean Beach at Narragansett Pier has not had an exceedance since 2000 and Mission Beach at Capistrano Place has never recorded an exceedance.

**Table 3-1. Relative Frequency of Historical AB411 Exceedances at Dog Beach, Ocean Beach and Mission Beach.**

| Year | Dog Beach # Exceed/Total # (% Exceed) | Ocean Beach # Exceed/Total # (% Exceed) | Mission Beach # Exceed/Total # (% Exceed) |
|---|---|---|---|
| 1999 | 16/70 (23%) | 1/15 (7%) | 0/19 (0%) |
| 2000 | 13/55 (19%) | 1/31 (3%) | 0/31 (0%) |
| 2001 | 15/68 (18%) | 0/31 (0%) | 0/31 (0%) |
| 2002 | 12/57 (17%) | 0/31 (0%) | 0/28 (0%) |

# Overview of River Findings

This section presents findings for the river system as a whole. Subsequent sections provide site descriptions, physical water quality data and bacterial water quality data. Storm drains and the Near Beach Diversion System are also discussed. Sections 5 – 8 provide information for the River, starting furthest upstream and finishing at the eastern extent of tidal influence. Section 9 provides data for Dog Beach and surrounding stations, as well as discusses the results of local bacterial source investigations. Ocean Beach and Mission Beach sites are presented in Section 10.

## 4.1 River Segment Source Identification Surveys

The first surveys conducted for this task occurred on October 14 and October 18, 2002 at six sites (Figure 4-1) throughout the Lower San Diego River. At each site, samples were collected synoptically three times each day (0800 hrs, 1200 hrs and 1600 hrs) at five equidistant stations across the river. Samples were analyzed for bacterial indicators (total and fecal coliforms and *Enterococcus*) as well as chemical and physical water quality parameters (pH, temperature, conductivity, total suspended solids (TSS) and ammonia).

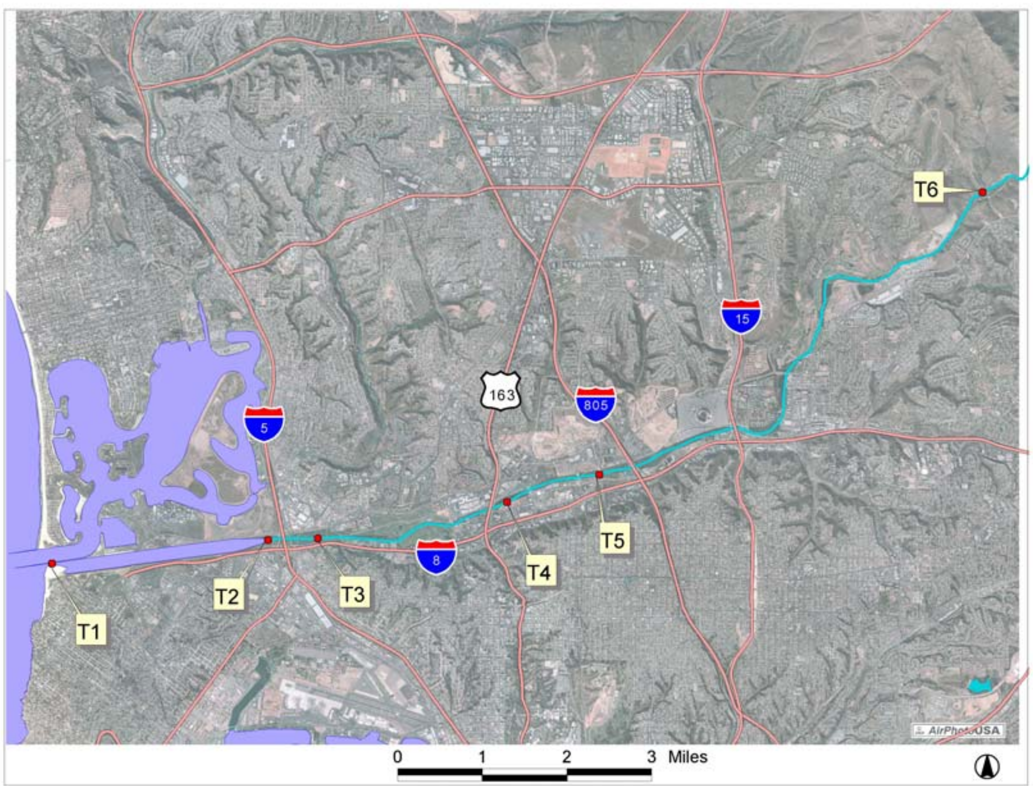



**Figure 4-1. Transect location map; Sampling conducted October 2002.**

This task continued through the 2003 dry weather season with the addition of 12 sampling sites (Figure 4-2). At each site, one, two or three samples were collected across the river (north, center and south sides) depending on the River width and access. These surveys were conducted 27 times from April 9, 2003 to August 24, 2003. At this time, the sampling site in Mission Trail Park (T6) was abandoned and the furthest upstream location became Ward Road (T5E), approximately 0.25 miles east of Interstate 15. Mission Trails Park (T6) was geographically too far removed from the rest of the sampling sites and a station closer was deemed more representative of bacterial levels entering the eastern side of the study area and more feasible to sample. Site 1 across the mouth of San Diego River was also abandoned and replaced with three stations which were more representative of the varied environmental conditions at Dog Beach. These stations spanned the length of Dog Beach and included a station located at the DEH's AB411 sampling site.


**Figure 4-2. Transect location map; Sampling conducted April – August 2003.**

Results from the preliminary investigations indicated that overall bacterial indicator concentrations were low throughout the river. On October 14, there was one exceedance of the total coliform criteria (one sample at Mission Valley YMCA (Site T3)), no exceedances of the fecal coliform criteria and only two exceedances of the *Enterococcus* criteria (two samples at Hwy 163 (Site T4)). The temporal and spatial variability of bacterial concentrations was illustrated by an increase in the number of samples that exceeded AB411 criteria on October 18, 2002. There were 15 exceedances of the total coliform criteria, 14 exceedances of the fecal coliform criteria and only 5 exceedances of the *Enterococcus* criteria (Table 4-1). A complete listing of sample results are presented in Appendix C and discussed in greater detail in Sections 5– 9.

**Table 4-1. Summary of samples exceeding AB411 criteria, October 18, 2002.**

| Site | # of Samples Exceeding AB411 Criteria | | |
|---|---|---|---|
| | Total Coliform | Fecal Coliform | *Enterococcus* |
| Transect 1 (Dog Beach) | 0 | 0 | 1 |
| Transect 2 (Just West of I-5) | 6 | 7 | 0 |
| Transect 3 (East of Morena Blvd.) | 0 | 0 | 0 |
| Transect 4 (HWY 163) | 0 | 0 | 0 |
| Transect 5 (Qualcomm Way) | 4 | 5 | 0 |
| Transect 6 (Mission Trails Park) | 5 | 2 | 4 |

During both sampling days, ammonia-nitrogen was not detected (at the detection limit of 1 mg/L) in any of the samples collected. Ammonia is a primary indicator of sewage contamination. The absence of detectable ammonia-nitrogen in any of the samples suggests that sewage was not present at the time of sampling.

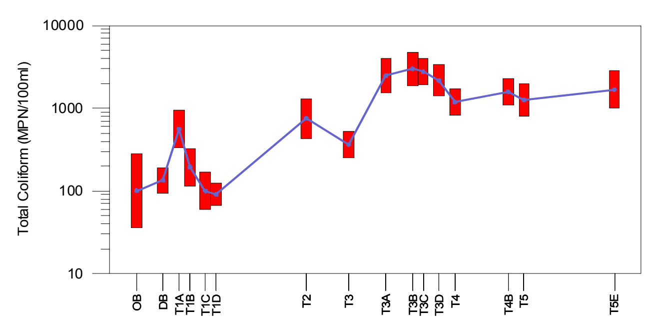



**Figure 4-3. Geometric mean of total coliforms at sites throughout San Diego River.**

Using data collected during the 2003 dry weather season, the graphs on the right illustrate the trends in bacterial levels for all three indicators (total coliform Figure 4-3, fecal coliform Figure 4-4, and *Enterococcus* Figure 4-5). Each of these graphs present the geometric mean for all samples collected at a sampling site and the associated 95% confidence interval (red boxes). The stations are displayed on the x-axis in relative geographic position to each other.

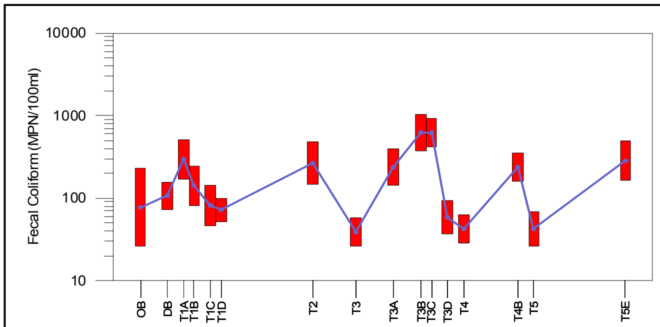



**Figure 4-4. Geometric mean of fecal coliforms at sites throughout San Diego River.**

The graphs show that there were localized areas throughout the River that had elevated bacterial levels. It also shows areas with high bacterial levels were not necessarily contributing to bacterial levels downstream. This was most evident in the levels of fecal coliforms upstream and downstream of the Riverwalk Golf Course and Fashion Valley Mall (the area bound by

Site T3 and Site T4 on the graphs). The order of magnitude increase in fecal coliform between Avenida del Rio (T3D) and Fashion Valley Road (T3C) appeared to decline immediately and that increase was no longer apparent behind the Mission Valley YMCA (T3).

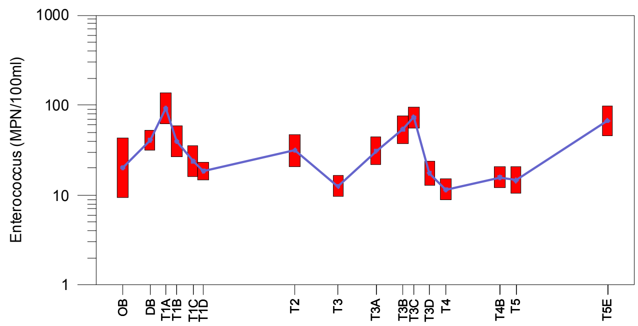



**Figure 4-5. Geometric mean of *Enterococcus* at sites throughout the San Diego River.**

The most important aspect of the data collected throughout the River, and as depicted in the following graphs, was that the levels of bacterial contamination around Dog Beach were higher than the closest upstream transect at Sunset Cliffs Blvd. Bridge (T1D). Statistical analyses confirmed that samples collected at Sunset Cliffs Blvd. Bridge (T1D) were significantly lower (alpha =0.05) than samples at the closest upstream site, Interstate 5 (T2), and lower than samples at the downstream sites at Outfalls 12 (T1B), 13, and 14 (T1A) for all three bacterial indicators. Samples collected at the Sunset Cliffs Blvd. Bridge (T1D) were also significantly lower than Dog Beach sites for the bacterial indicator, *Enterococcus*. This suggests that the water quality degradation on Dog Beach was most influenced by local sources, rather than the River as a whole.

The data for the chronic study for San Diego River were analyzed using a repeated measure ANOVA that takes into account the autocorrelation that can be associated with sampling the same location repeatedly through time. Autocorrelation refers to the tendency for, in this case, a particular location to be similar from one sampling to the next. The ANOVA tested for differences in transects, taking into account the repeated sampling through time and the differing numbers of samples at each location. The least-square means (adjusted for the time factor) of the three bacterial measurements at each transect location were compared using a Tukey comparison which contrasted each transect with each other one.

The results derived from the 2003 dry weather data indicate that upstream segments of the River were not a chronic source of bacterial contamination to Dog Beach (ANOVA). This does not suggest that the River is never a potential source. Historical data show that sewage spills and large storm events have impacted Dog Beach. These were acute sources which, during the course of this study, did not occur. Episodic events as these are still likely to impact water quality at area beaches.

Site by site descriptions and data presentation are provided in Sections 5 through 10. The Sections represent segments of the River, starting with upstream locations first (Section 5) and continuing downstream to the beaches (Section 10). The segments of the River were divided based on a combination of geographic and land use patterns. Section 9 presents the data collected at stations around Dog Beach and discusses the studies performed in the investigation of local sources.

## 4.2 Near Beach Diversion Systems

The Lower San Diego River has seven pump stations to divert storm drain flows to the sanitary sewer system (Figure 4-6). These diversions reduce the amount of urban runoff and storm water that enters the River.

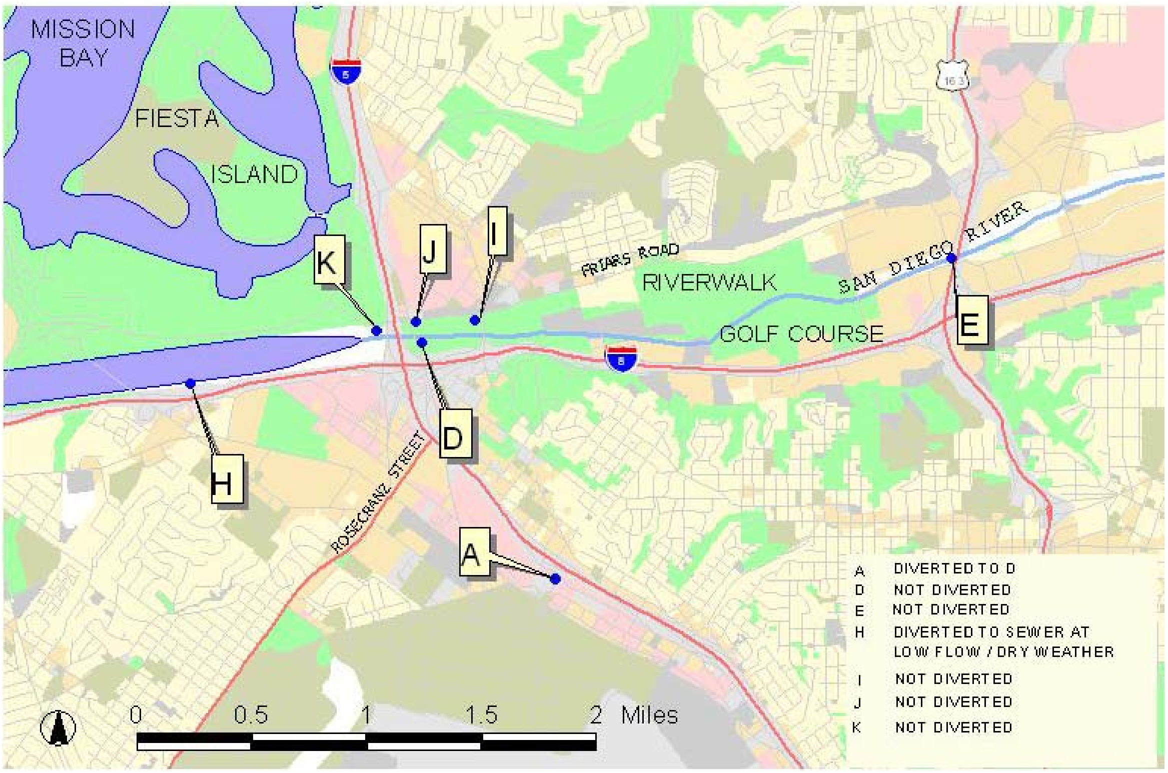



**Figure 4-6. Location map of Pump Stations discharging to San Diego River.**

Pump Stations H and D were investigated on November 25, 2002. Follow-up investigations to Pump Station D were performed on December 2, 2002 and January 2 and 27, 2003. Investigations of Pump Stations A, E, I, J, and K were performed on May 19, 2003.

Of the seven pump stations, only Pump Station H is diverted to the sanitary sewer system at low flow. The remaining pump stations discharge to the River (Pump Station A pumps to Pump Station D). Pump Stations E, I, J and K discharge to wetland areas flanking the River. Pump Station D is the largest of the pump stations and discharges the greatest volume of effluent to the River. Pump Stations I, J and K are generally observed to be dry during dry weather periods and therefore would not be a significant source of bacterial contamination to the River. Sections 7 – 8 detail investigations conducted at the pump stations and pump station maintenance procedures.

Additional investigations at Pump Station D revealed that effluent had high levels of bacterial concentrations (up to 800,000 MPN/100 mL total coliform, up to 50,000 MPN/100 mL fecal coliform and up to 3,448 MPN/100 mL *Enterococcus*). Discharge of this effluent negatively impacted water quality directly downstream (within 50 feet) of the pump station. On December 2, 2002, samples collected downstream of the outfall at pre- and post- discharge times showed a one to two order of magnitude increase in bacterial indicator concentrations.

Although Pump Station D is providing bacteria to the River as documented in samples collected on December 2, 2002, during the course of this study, it was not evident that these discharges were impacting Dog Beach. Concurrent sampling at Dog Beach on December 2, 2002 did not show similarly elevated levels of bacterial concentrations. Samples collected at the AB411 sampling site had bacterial concentrations of 80 MPN/100 mL, 40 MPN/100 mL and 10 MPN/100 mL for total coliform, fecal coliform and *Enterococcus*, respectively.

Additional information regarding the pump station investigations, as well as operations and maintenance procedures, can be found in Sections 7 and 8.

# Mission Trails to Mission Valley


This segment of the River is the easternmost area studied. The River enters the eastern portion of this segment in the Mission Trails Park. Mission Trails Park comprises 5,800 acres and offers multiple outdoor recreational uses for the public. Heavy vegetation occurs along the banks of the River through the park. The River exits the park and continues downstream, winding through sensitive habitat areas, active mining operations, and commercial and industrial development. The western boundary of this segment is confined by Interstate-15.

This segment of the River is the location of two sampling stations (Table 5-1).

**Table 5-1. Site description and geographic coordinates.**

| River Site # | Site Description | Lat.[1] | Long. [1] |
|---|---|---|---|
| T6 | In Mission Trails Regional Park, at Jackson Street | 32° 49.233 | 117° 03.817 |
| T5E | Just east of Ward Road | 32° 46.818 | 117° 06.614 |

[1] GPS coordinates are in Degrees Decimal Minute format (DD MM.MMMM), NAD 83.

## 5.1 Water Quality and Potential Source of Impairment by Site

### 5.1.1 Mission Trails (Transect 6)

Site Description

This site was located north of Jackson Drive in Mission Trails Park (Figure 5-1). Initially, the Mission Trails (T6) site was planned to be a reference location, further upstream, to which the other sites could be compared. However, during a site reconnaissance it was determined that the original planned location was inappropriate for sampling, due to insufficient flow, and the site was moved downstream. This site could not be considered a true reference site because it was located downstream of another urbanized area. However, because it was located within the open space area of Mission Trails Regional Park, the effects of urbanization on the water quality were expected to be minimal. This site was sampled twice during the initial investigation with 30 samples collected in October 2002 only.


**Figure 5-1. Sampling sites.**

The River was approximately ten feet wide and a few inches deep during sampling in October, 2002. It is surrounded by vegetation and rocks as shown in Figure 5-2.

**Figure 5-2. Transect 6 (October 2002).**

Water Quality

This location was part of the initial transect investigations and was sampled on two occasions on October 14 and 18, 2002 (Figure 5-3).

The samples for bacterial analyses and chemical/physical water quality measurements were taken at five stations equally spaced along the length of the transect (sampling and testing methods are found in Appendix C). Sample times were 0800 hrs, 1200 hrs, and 1600 hrs. A total of 30 samples were collected during the two days.

Chemical and physical water quality measurements included pH, temperature, conductivity, ammonia and total suspended solids. The results of all measurements are found in Appendix B. A brief summary of the range of results for each parameter are shown in Table 5-2 below. The chemical and physical data collected at the Mission Trails (T6) site was consistent with results expected for a shallow and low flow location.

**Figure 5-3. Water quality sampling at T6.**

**Table 5-2. Chemical and physical measurements at the Mission Trails Site (T6) in October 2002.**

| Parameter | Dates | Range |
|---|---|---|
| pH | October 14 and 18, 2002 | 7.00 - 7.34 |
| Temperature | October 14 and 18, 2002 | 16.0 - 20.0°C |
| Conductivity | October 14 and 18, 2002 | 2.15 - 3.60 mS/cm |
| Ammonia | October 14 and 18, 2002 | <1 mg/L |
| Total Suspended Solids | October 14 and 18, 2002 | 2.2 – 13.0 mg/L |

The Mission Trails site (T6) did not have a persistent source of bacteria during the initial investigations and the range for all three indicators was comparable to the data obtained at the other five initial sites at the Mouth of the River (T1), Interstate 5 (T2), Mission Valley YMCA (T3), Highway 163 (T4) and Qualcomm Way (T5). Bacteria concentrations ranged from non-detect for two of the three indicators to 170,000 MPN/100 mL for total coliform, 1,300 MPN/100 mL for fecal coliform and 373 MPN/100 mL for *Enterococcus*, as shown below in Table 5-3. At this site, the three bacterial indicators had 8 out of 30 (26.7%) of the test results as non-detect. Appendix B presents all sample results in tabular and graphical format.

**Table 5-3. Bacterial indicator results for the Mission Trails site (T6).**

| Parameter | Dates | Range (MPN/100 mL) |
|---|---|---|
| Total coliform | October 14, 2002 – October 18, 2002 | 110 – 170,000 |
| Fecal coliform | October 14, 2002 – October 18, 2002 | <20 – 1,300 |
| *Enterococcus* | October 14, 2002 – October 18, 2002 | <10 – 373 |

Of the 30 samples collected over the two October days, 6 (20%) would have exceeded AB411 standards. All these exceedances took place on the second day of sampling. Additional information on AB411 criteria is shown in Table 5-4.

**Table 5-4. AB411 exceedances summary chart for Mission Trails (T6) data.**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| (T6) | No. of Samples | 30 | 30 | 30 |
| | No. of Tests Exceeding AB411 criteria | 5 (16.7%) | 2 (3.3%) | 4 (13.3%) |
| | No. of Samples Exceeding Any AB411 criteria | 6 (20%) | | |
| | No. of Sample Days | 2 | | |
| | No. of Days Exceeding AB411 criteria | 1 (50%) | | |

Mission Trails site (T6) was not sampled during any of the succeeding studies since due to its location and consistent results with downstream locations. Instead, Ward Road (T5E) site (described below) was selected to represent water quality inputs from areas east of Interstate 15.

### *5.1.2 Ward Road (Transect 5E)*

<u>Site Description</u>

This site was located just east of Ward Road (Figure 5-1). At this site, the River was shallow and narrow with water flowing at a steady rate. The area surrounding the River was the site of construction of the San Diego Trolley line to San Diego State University during this project. The River bed was modified with the addition of gravel surrounding the newly constructed bridge support structures and the bridge provides some shade over the River as shown in Figure 5-4. A

**Figure 5-4. Site T5E looking to the southeast.**

gravel weir, possibly a BMP for construction work, was located approximately 20 feet downstream of the sampling station.

Water Quality Results and Potential Sources

This site was added as part of the project's Chronic Input Investigations sampling task. It was sampled 27 times over 27 different days from April 9, 2003 to August 24, 2003.

Water quality tests consisted of field measurements for pH (range 6.93 – 7.47) and temperature (range 21.1 – 22.6$^0$C) from July 24 through August 23, 2003.

Total coliform ranged from 230 to 17,000 MPN/100 mL. Fecal coliform ranged from 20 to 8,000 MPN/100 mL. *Enterococcus* ranged from 10 to 457 MPN/100 mL. Summaries of the data can be found in Table 5-5 below. At this site, all three bacterial indicators had test results above the non-detectable limit. Appendix B presents all sample results in tabular and graphical format.

**Table 5-5. Bacterial indicator results for the Ward Road (T5E) site.**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | April 9, 2003 – August 24, 2003 | 1,871 | 230 – 17,000 |
| Fecal coliform | April 9, 2003 – August 24, 2003 | 289 | 20 – 8,000 |
| *Enterococcus* | April 9, 2003 – August 24, 2003 | 79 | 10-457 |

This site did exceed AB411 criteria 19 of the 27 days it was sampled. Of the 27 samples, 19 (70.4%) had bacterial concentrations that would have exceeded AB411 standards. Additional information on AB411 criteria is shown in Table 5-6.

**Table 5-6. AB411 exceedances summary chart for Ward Road (T5E) data.**

<table>
<tr><th>Site</th><th></th><th>Total Coliform</th><th>Fecal Coliform</th><th>Enterococcus</th></tr>
<tr><td rowspan="5">T5E</td><td>No. of Samples</td><td>27</td><td>27</td><td>27</td></tr>
<tr><td>No. of Tests Exceeding AB411 criteria</td><td>12 (44.4%)</td><td>14 (51.9%)</td><td>9 (33.3%)</td></tr>
<tr><td>No. of Samples Exceeding Any AB411 criteria</td><td colspan="3">19 (70.4%)</td></tr>
<tr><td>No. of Sample Days</td><td colspan="3">27</td></tr>
<tr><td>No. of Days Exceeding AB411 criteria</td><td colspan="3">19 (70.4%)</td></tr>
</table>

Total coliform levels at the Ward Road (T5E) site were consistent with sampling sites located downstream from this site. The geometric mean for total coliform is comparable to that found at the El Camino del Este (T4B) and Highway 163 (T4) sites located in Mission Valley; and the Avenida del Rio (T3D) site in Fashion Valley.

Fecal coliform levels were also comparable to levels seen at Camino del Este (T4B), Riverwalk Golf Course West (T3A) and Interstate 5 (T2). Concentrations of *Enterococcus* at Ward Road

(T5E) were the second highest recorded and comparable to the Fashion Valley Road (T3C) site. The highest geometric mean of values for *Enterococcus* were found at the Outfall 13 and 14 site (T1A), as explained in Section 9 – Sports Arena Bridge to Dog Beach.

The sources of total coliform, fecal and *Enterococcus* were not specifically identified, but may include urban runoff, vegetation and wildlife just upstream of Ward Road (T5E).

### 5.2 Storm Drain Infrastructure / Diversion System

Storm drain infrastructure in this segment of the River varies depending on the adjacent land use. Residential neighborhoods with urban runoff enter the River at numerous points. This segment of the River does not have diversion system infrastructure and the sanitary sewer system which is mainly located in or near-by the River is clearly labeled and painted bright green as shown in Figure 5-5. Public awareness and education was evident and patrols of the area by City staff were frequent. There was no evidence of sewer infrastructure failure during field visits to the two sites in this segment of the River and the bacteria data did not indicate spills or overflows as a persistent source.

**Figure 5-5. Sanitary sewer at Mission Trails.**

# Mission Valley

## SECTION 6


This segment of the River is approximately three miles long and confined on the east by Interstate-15 and on the west by Highway 163. The segment is intersected by Interstate-805 making it the segment with the most exposure to highways. The River along this section was characterized as having densely vegetated, willow riparian habitat. This segment includes Qualcomm Stadium with extensive impervious surfaces (parking lots) on the north near Interstate-15 and Mission Valley Center, which has extensive parking areas and is located on the south bank near Highway 163. The remaining uses are a mix of commercial and residential including hotels and high-rise office buildings. Commercial/residential development was under way on the north side of Friars Road during this project.

This segment of the River is the location of three sampling stations (Table 6-1, Figure 6-1).

**Table 6-1. Site Description and Geographic Coordinates.**

| River Site # | Site Description | Lat.[1] | Long. [1] |
|---|---|---|---|
| T5 | West side of bridge at Qualcomm Way | 32° 46.818 | 117° 06.614 |
| T4B | East side of Camino del Este | 32° 46.362 | 117° 08.675 |
| T4 | East of HWY 163 (at the end of Hazard Center Rd) | 32° 46.030 | 117° 09.709 |

[1] GPS coordinates are in Degrees Decimal Minute format (DD MM.MMMM), NAD 83.


**Figure 6-1. Sampling sites.**

## 6.1 Water Quality and Potential Sources of Impairment by Site

### 6.1.1 Qualcomm Way (Transect 5)

Site Description

This site was located at Qualcomm Way (Figure 6-1) and was typically sampled at both the north (T5-N) and south (T5-S) edge of the River with the exception of the initial investigations in October 2002 when five equally spaced stations were sampled. The River was approximately 150 feet wide at this point and sampling took place on the west side of the bridge. Storm drain inlets were located on both the north and south banks of the River draining Qualcomm Way.

**Figure 6-2. Storm drain inlet with BMP at T5-N in October 2002.**

During sampling in October 2002, there was construction on the north side of the river adjacent to this transect and best management practices (BMPs) were installed at the inlets to these two storm drains as shown in Figure 6-2.

During subsequent visits to the site, conditions generally remained unchanged. The appearance of the water did become slightly more turbid and color changed from blue/green to slightly brown in the late summer months. The vegetation next to the two sampling station was noted to increase in size and abundance with the warmer weather and longer days.

<u>Water Quality</u>

This location was part of the initial River Segment Source Investigations and was sampled on two occasions on October 14 and 18, 2002 (Figure 6-3).

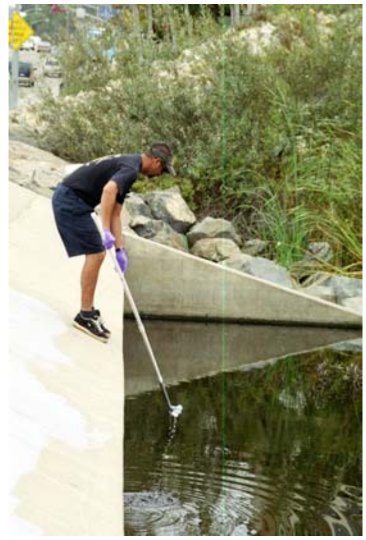


**Figure 6-3. Sampling at T5.**

The samples for bacterial analyses and chemical/physical water quality measurements were taken at five stations equally spaced along the length of the transect (sampling and testing methods are found in Appendix C). Sample times were 0800 hrs, 1200 hrs, and 1600 hrs. A total of 30 samples were collected during the two days.

Chemical and physical water quality measurements included pH, temperature, conductivity, ammonia and total suspended solids and are shown in Table 6-2 below. The results of all measurements are found in Appendix B.

**Table 6-2. Chemical and physical measurements at Qualcomm Way (T5) in October 2002.**

| Parameter | Dates | Range |
|---|---|---|
| pH | October 14 and 18, 2002 | 7.54 – 7.77 |
| Temperature | October 14 and 18, 2002 | 18.2- 21.0°C |
| Conductivity | October 14 and 18, 2002 | 2.15 - 3.64 mS/cm |
| Ammonia | October 14 and 18, 2002 | <1 mg/L |
| Total Suspended Solids | October 14 and 18, 2002 | 1.9 – 3.2 mg/L |

Bacterial concentrations ranged from non-detect for two of the three indicators to 50,000 MPN/100 mL for total coliform, and fecal coliform and 96 MPN/100 mL for *Enterococcus*, as shown in Table 6-3. Appendix B presents all sample results in tabular and graphical format.

**Table 6-3. Bacterial indicator results for Qualcomm Way (T5) during initial transects investigations.**

| Parameter | Dates | Range (MPN/100 mL) |
|---|---|---|
| Total coliform | October 14 and 18, 2002 | 20 – 50,000 |
| Fecal coliform | October 14 and 18, 2002 | <20 – 50,000 |
| *Enterococcus* | October 14 and 18, 2002 | <10-96 |

Additional sampling was done during the Chronic Input Investigations Studies at Qualcomm Way (T5) between June 9 and August 24, 2003. Over 19 different days, 38 samples were collected for bacterial testing. The concentrations ranged from non-detect for two of the three indicators to 13,000 MPN/100 mL for total coliform, 300 MPN/100 mL for fecal coliform and 106 MPN/100 mL for *Enterococcus*, as shown in Table 6-4. Appendix B presents all sample results in tabular and graphical format.

**Table 6-4. Bacterial indicator results for Qualcomm Way (T5) during the Chronic Investigations Study.**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | June 9, 2003 – August 24, 2003 | 918 | 20 – 13,000 |
| Fecal coliform | June 9, 2003 – August 24, 2003 | 44 | <20 – 300 |
| *Enterococcus* | June 9, 2003 – August 24, 2003 | 16 | <10-106 |

This site exceeded AB411 criteria on 3 of the 19 days it was sampled. Of the 38 samples, 7.9% (3 of 38) had bacterial concentrations that would have exceeded AB411 standards. Additional information on AB411 criteria is shown in Table 6-5.

**Table 6-5. AB411 exceedances summary chart for Qualcomm Way (T5).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T5 | No. of Samples | 38 | 38 | 38 |
| | No. of Tests Exceeding AB411 criteria | 2 (5.3%) | 0 (0%) | 1 (2.6%) |
| | No. of Samples Exceeding Any AB411 criteria | 3 (7.9%) | | |
| | No. of Sample Days | 19 | | |
| | No. of Days Exceeding AB411 criteria | 3 (15.8%) | | |

The geometric mean for total coliform at Qualcomm Way (918 MPN/100 mL) was significantly lower than 1.5 miles upstream at Ward Road (1,871 MPN/100 mL) and three sites downstream, Camino del Este (1,761 MPN/100 mL), Highway 163 (2,002 MPN/100 mL) and Avenida del Rio in Fashion Valley (2,025 MPN/100 mL). Similarly, the geometric mean for fecal coliform at Qualcomm Way (44 MPN/100 mL) was significantly lower than the upstream station at Ward Road (289 MPN/100 mL) and downstream at Camino del Este (291 MPN/100 mL). Fecal coliform did not exceed AB411 criteria at Qualcomm Way. The geometric mean of *Enterococcus* at Qualcomm Way (16 MPN/100 mL) was significantly lower than that documented upstream at Ward Road (79 MPN/100 mL), however, the downstream sites in the Fashion Valley Mall area had comparable geometric means (ranging 12-18 MPN/100 mL) to samples collected at Qualcomm Way. The AB411 standard for *Enterococcus* was only exceeded once at this site.

The lower concentrations of all three bacterial indicators at Qualcomm Way (T5) may be explained by the different environmental conditions such as the larger water volume due to its increased width and depth and increased exposure to sunlight due to decreases in arborescent canopy. These factors can reduce the bacterial levels in the River.

Water quality measurements consisted of measuring pH (range 7.5 to 7.9) and temperature (range 22.6 to 27.5$^0$C) from July 24 through August 23, 2003.

### *6.1.2 Camino del Este (Transect 4B)*

Description

This location was part of the Chronic Input Investigations sampling task and was sampled between April 9 and August 24, 2003. The location was selected to monitor the water quality just upstream of Mission Valley Center. Samples were collected on the north (T4B-N) and south (T4B-S) edge of the River on the east side of Camino del Este (Figure 6-1). The River was approximately 225 feet wide just upstream of the sample site and narrows as it goes through the culvert at Camino del Este (Figure 6-4). This site was typically inhabited by birds, predominantly ducks, that were frequently fed by citizens.

**Figure 6-4. Transect 4B looking north and upstream of Camino del Este.**

Through the course of this project the appearance of the water (at this site) changed from clear to slightly turbid and color from blue/green to slightly brown or brownish-green.

Water Quality

Samples at Camino del Este (T4B) were collected 54 times over 27 different days for bacteria levels. Sampling was performed between April 9, 2003 and August 24, 2003. Samples were collected on the north (T4B-N) and south (T4B-S) edge of the River. Bacterial concentrations ranged from 230 to 13,000 MPN/100 mL for total coliform, non-detect to 5,000 MPN/100 mL for fecal coliform and non-detect to 195 MPN/100 mL for *Enterococcus*, as shown in Table 6-6. Appendix B presents all sample results in tabular and graphical format.

**Table 6-6. Bacterial indicator results for Camino del Este (T4B).**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | April 9, 2003 – August 24, 2003 | 1,761 | 230 – 13,000 |
| Fecal coliform | April 9, 2003 – August 24, 2003 | 291 | <20 – 5,000 |
| *Enterococcus* | April 9, 2003 – August 24, 2003 | 18 | <10-195 |

This site exceeded AB411 criteria on 15 of the 27 days it was sampled. Of the 54 samples collected, 39% (21 of 54) had bacterial concentrations that would have exceeded AB411 standards. Additional information on AB411 criteria is shown in Table 6-7.

**Table 6-7. AB411 exceedances summary chart for Camino del Este (T4B).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T4B | No. of Samples | 54 | 54 | 54 |
| | No. of Tests Exceeding AB411 criteria | 19 (35.2%) | 12 (22.2%) | 1 (1.9%) |
| | No. of Samples Exceeding Any AB411 criteria | 21 (38.9%) | | |
| | No. of Sample Days | 27 | | |
| | No. of Days Exceeding AB411 criteria | 15 (55.6%) | | |

Total coliform levels at Camino del Este (T4B) were consistent with sampling sites located downstream from this site. The geometric mean for total coliform was lower than that recorded at the closest upstream station (Qualcomm Way) and similar to that found at the next two downstream stations Highway 163 (T4) and Avenida del Rio (T3D) in Fashion Valley. There was an increase in fecal coliform levels at this sampling site compared to the closest upstream and downstream sites, perhaps due to a localized source or more favorable environmental conditions. *Enterococcus* levels at Camino del Este (T4B) were minimal, with a geometric mean of 18 MPN/100 mL.

Water quality measurements were taken at Camino del Este (T4B) from July 24 through August 23, 2003 on 6 different dates with pH ranging from 7.61 to 7.86 and temperature from 24.1 to 25.7$^0$C.

### *6.1.3 Highway 163 (Transect 4)*

Description

This transect was located below the bridge structure for Highway 163 (Figure 6-1). It was originally sampled during the initial investigations in October 2002. This site was an important sampling location because it was downstream of Mission Valley Center and just upstream of Fashion Valley Mall. The River becomes narrow and shallow at this undeveloped site (Figure 6-5). It is a popular location for fishing and birds were frequently seen at this site.

**Figure 6-5. Narrowing River just east of Highway 163 at Transect 4.**

Water Quality

The five chemical and physical water quality measurements taken at this site in October 2002 are summarized in Table 6-8 below. The results of all measurements are found in Appendix B.

**Table 6-8. Chemical and physical measurements at HWY 163 (T4) in October 2002.**

| Parameter | Dates | Range |
|---|---|---|
| pH | October 14 and 18, 2002 | 7.74 – 7.99 |
| Temperature | October 14 and 18, 2002 | 19.6- 21.6°C |
| Conductivity | October 14 and 18, 2002 | 3.45 - 3.53 mS/cm |
| Ammonia | October 14 and 18, 2002 | <1 mg/L |
| Total Suspended Solids | October 14 and 18, 2002 | 5.7 – 10.6 mg/L |

During the initial transects investigation the sample site at Highway 163 (T4) was sampled 30 times over two days. Bacterial concentrations ranged from non-detect for all three indicators to 5,000 MPN/100 mL for total coliform, 130 MPN/100 mL for fecal coliform and 173 MPN/100 mL for *Enterococcus*.

Additional sampling was done during the Chronic Input Investigations Studies between April 9 and August 24, 2003. Samples were collected on the north (T4-N) and south (T4-S) edge of the River as opposed to the five stations of the initial study.

On 27 different days, 54 samples were collected for bacterial testing. Bacterial concentrations ranged from non-detect for two of the three indicators to 24,000 MPN/100 mL for total coliform, 2,300 MPN/100 mL for fecal coliform and 204 MPN/100 mL for *Enterococcus*, as shown in Table 6-9. Appendix B presents all sample results in tabular and graphical format.

**Table 6-9. Bacterial indicator results for HWY 163 (T4).**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | April 9, 2003 – August 24, 2003 | 2002 | 20 – 24,000 |
| Fecal coliform | April 9, 2003 – August 24, 2003 | 57 | <20 – 2,300 |
| *Enterococcus* | April 9, 2003 – August 24, 2003 | 12 | <10 - 204 |

This site exceeded AB411 criteria on 5 of the 27 days it was sampled. Of the 54 samples, 9 samples (17%) had bacterial concentrations that would have exceeded AB411 standards. Additional information on AB411 criteria is shown in Table 6-10.

**Table 6-10. AB411 exceedances summary chart for HWY 163 (T4).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T4 | No. of Samples | 54 | 54 | 54 |
| | No. of Tests Exceeding AB411 criteria | 8 (14.8%) | 4 (7.4%) | 1 (1.9%) |
| | No. of Samples Exceeding Any AB411 criteria | 9 (16.7%) | | |
| | No. of Sample Days | 27 | | |
| | No. of Days Exceeding AB411 criteria | 5 (18.5%) | | |

The geometric mean for total coliform at Highway 163 (2,002 MPN/100 mL) was comparable to that found upstream at Camino del Este (T4B) located in the Mission Valley and downstream at Avenida del Rio (T3D) in Fashion Valley. The fecal coliform levels at Highway 163 (T4) were low and did not exceed AB411 standards. The geometric mean for fecal coliform at this site was 57 MPN/100 mL compared to 291 MPN/100 ml approximately 1 mile upstream at Camino del Este (T4B). *Enterococcus* levels observed at the Highway 163 (T4) were found to be amongst the lowest on the River and as shown in Table 6-10 only one exceedance was recorded at this site.

Water quality measurements were taken from July 24 through August 23, 2003 on six different dates for pH (range = 7.94 to 8.20) and temperature (range = 24.9 and 27.1 $^{0}$C).

## 6.2 Storm Drain Infrastructure/Diversion System

The storm drain system in this segment of the River includes numerous outfalls including major areas such as Qualcomm Stadium and commercial development along the segment. The storm drain outfalls do not include diversion systems to the sanitary sewer system.

### 6.2.1 Outfall Investigations

On July 16, 2003 field crews inspected outfalls along the San Diego River from Highway 163 to Qualcomm Way. Attempts were made to investigate six outfall located in this segment. Vegetation along the shores of the river in this area is very dense and crews were unable to locate five outfall locations that appear on the City's storm drain map. The sixth outfall, located under the San Diego River bridge structure of Qualcomm Way, was dry.

# Fashion Valley


This segment of the River comprises the Fashion Valley community. It is bound by Highway 163 on the east and Fashion Valley Road on the west. The River decreases in width to approximately 30 feet and river flow increases compared to the next upstream segment. The River supported a corridor of riparian willow vegetation. Numerous homeless encampments were located along the river banks in this segment. Commercial businesses were located on both sides of the River throughout this segment, including Fashion Valley Mall on the north side.

Two sampling locations, Avenida del Rio (T3D) and Fashion Valley Road (T3C) were located within this segment (Table 7-1 and Figure 7-1).

**Table 7-1. Site description and geographic coordinates.**

| River Site # | Site Description | Lat.[1] | Long. [1] |
|---|---|---|---|
| T3D | East side of Avenida del Rio | 32° 45.986 | 117° 09.850 |
| T3C | East side of Fashion Valley Road | 32° 45.861 | 117° 10.206 |

[1] GPS coordinates are in Degrees Decimal Minute format (DD MM.MMMM), NAD 83.


**Figure 7-1. Location of Sites T3C and T3D in Fashion Valley.**

## 7.1 Water Quality and Potential Sources of Impairment by Site

### 7.1.1 Avenida del Rio (Transect 3D)

<u>Site Description</u>

This site was located on the east side of Avenida del Rio, approximately 650 feet downstream of Pump Station E (Figure 7-1). This transect was sampled on both the north (T3D-N) and south (T3D-S) edges of the River. The River flows under Avenida del Rio through a series of corrugated metal pipes (Figure 7-2).


**Figure 7-2. Corrugated metal pipes at transect T3D near sampling point.**

The river banks supported a dense willow riparian vegetation. Approximately 50 feet upstream, there was a riffle in the river. Rubbish, including a shopping cart, were observed on the banks and in the river. Numerous homeless encampments were along the banks.

Water Quality

This location was part of the Chronic Input Investigation Studies. This transect was monitored for chemical and physical measurements and bacterial indicators. Samples were collected from both the south and north edges except on three occasions.

Bacteria data was collected from May 24 through August 24, 2003 on 21 different sample dates. Total coliform results ranged from a low of 300 to 24,000 MPN/100 mL. The geometric mean for total coliform at this transect was 2,025 MPN/100 mL. Fecal coliform results ranged from non-detect to 3,000 MPN/100 mL with a geometric mean of 79 MPN/100 mL for all data points. *Enterococcus* ranged from non-detect to 75 MPN/100 mL with a geometric mean of 17 MPN/100 mL. Summaries of the data can be found in Table 7-2 below. Appendix B presents all sample results in tabular and graphical format.

**Table 7-2. Bacterial indicator results for T3D.**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | May 24 – August 24, 2003 | 2,025 | 300 - 24,000 |
| Fecal coliform | May 24 – August 24, 2003 | 79 | <20 - 3,000 |
| *Enterococcus* | May 24 – August 24, 2003 | 17 | <10 - 75 |

AB411 criteria were exceeded on 7 out of 21 days for any of the indicators. Additional information on AB411 criteria is shown in Table 7-3.

**Table 7-3. Summary of T3D sampling site indicator bacteria compared to AB411 criteria.**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T3D | No. of Samples | 40 | 41 | 42 |
| | No. of Tests exceeding AB411 criteria | 10 (25.0%) | 7 (17.0%) | 1 (2.4%) |
| | No. of Samples Exceeding Any AB411 criteria | 7 (33.3%) | | |
| | No. of Sample Days | 21 | | |
| | No. of Days Exceeding AB411 criteria | 7 (33.3%) | | |

The geometric means for all three bacterial indicators from this transect are comparable to the upstream location at T4 (east of Highway 163). There was probably little change in water quality due to proximity of the two sites since they were less than a quarter of a mile apart. In between Avenida del Rio (T3D) and Highway 163 (T4) was the location of Pump Station E (described in Section 7.2.1below). The data show that Pump Station E discharges, if they took place during the dates monitored, does not act as a significant source of bacteria to the River.

Water quality data was measured on six dates from July 21 through August 23, 2003 for pH ranging from 7.66 to 8.03 and temperature from 24.3 to 26.5$^0$C.

### 7.1.2 Fashion Valley Road (Transect 3C)

**Figure 7-3. Location of sampling points T3C-N and T3C-S.**

Site Description

This transect was located at Fashion Valley Road, downstream of Fashion Valley Mall and upstream of the Riverwalk Golf Course (Figure 7-1). Sampling was performed on both the north (T3C-N) and south (T3C-S) edges of the River. The River flowed under Fashion Valley Road via a series of channels lined with corrugated pipe (Figure 7-3). Sampling was performed at the edge of the ramp-like structure on the northern and southern most channels that showed a steady flow of water.

Water Quality

This location was part of the Chronic Input Investigation Studies of bacteria to San Diego River and was monitored for chemical and physical measurements and bacterial indicators

Basic water quality measurements for pH and temperature were recorded on six dates from July 24 through August 23, 2003. The readings for pH ranged from 7.60 to 7.87 and temperature from 24.1 to 25.2$^0$C.

Bacteria samples were collected from April 9 through August 24, 2003 for a total of 27 sample dates at both the south and north banks of the River. Total coliform results ranged from a low of 500 to 30,000 MPN/100 mL and a geometric mean of 3,967 MPN/100 mL for all data points. Fecal coliform results ranged from less than <20 to 13,000 MPN/100 mL with a geometric mean of 910 MPN/100 mL for all data points. *Enterococcus* ranged from less than <10 to 305 MPN/100 mL with a geometric mean of 76 MPN/100 mL. Summaries of the data can be found in Table 7-4 below. Appendix B presents all sample results in tabular and graphical format.

**Table 7-4. Bacterial indicator results for T3C.**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | April 9 – August 24, 2003 | 3,967 | 500 - 30,000 |
| Fecal coliform | April 9 – August 24, 2003 | 910 | <20 - 13,000 |
| *Enterococcus* | April 9 – August 24, 2003 | 76 | <10 - 305 |

AB411 criteria were exceeded on 24 out of 27 days for any of the indicators. Additional information on AB411 criteria is shown in Table 7-5.

**Table 7-5. Summary of T3C sampling site indicator bacteria compared to AB411 criteria.**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T3C | No. of samples | 54 | 54 | 54 |
| | No. of Tests exceeding AB411 criteria | 40 (74.1%) | 39 (72.2%) | 17 (31.5%) |
| | No. of Samples Exceeding Any AB411 criteria | 24 (88.9%) | | |
| | No. of Sample Days | 27 | | |
| | No. of Days Exceeding AB411 criteria | 24(88.9%) | | |

This monitoring site is approximately 0.4 miles downstream from Avenida del Rio (Figure 6-4) and receives runoff from Fashion Valley Mall. Total coliform levels at this site were the highest observed in the River with a geometric mean of 3,967 MPN/100 mL. The next closest transect upstream, Avenida del Rio (T3D), had a geometric mean of 2,025 MPN/100 mL. Also, the number of tests that exceed AB411 criteria increased from 10 (25%) at Avenida del Rio (T3D) to 40 (74.1%) at Fashion Valley Road (T3C).

Similar to total coliform at this site, fecal coliform levels were also the highest recorded in the river. The geometric mean at Fashion Valley Road (T3C) was 910 MPN/100 mL compared to 79 MPN/100 mL at Avenida del Rio (T3D). Comparison of AB411 criteria indicated that exceedances for fecal coliform increased from 7 of 41 (17.0%) at Avenida del Rio (T3D) to 39 of 54 (72.2%) at Fashion Valley Road (T3C).

*Enterococcus* levels were also amongst the highest documented for the River. The *Enterococcus* geometric mean was 4.5 times higher at Fashion Valley Road (T3C) than Avenida del Rio (T3D) (76 MPN/100 mL and 17 MPN/100 mL, respectively). Comparison of AB411 exceedances also showed the change in bacteria levels. Samples collected at Fashion Valley Road (T3C) exceeded standards 31.5% (17 of 54) of the time compared to 2.4% (1 of 41) of samples collected at Avenida del Rio (T3D).

The overall discussion of results is found in Sections 11 of the report, but it's important to note that the high bacteria levels found at T3C tend to decrease with distance downstream. Likely sources of the bacteria at this site include urban runoff and illegal discharges from the surrounding area including Fashion Valley Mall, human feces (from a large transient and homeless population), wildlife and decaying vegetation.

## 7.2 Storm Drain Infrastructure/Diversion System

This segment of the River has several outfalls that contribute urban runoff, dewatering discharges and storm water. Pump Station E was also located within this segment.

### 7.2.1 Pump Station E

Pump Station E is located just west of Highway 163 on the south bank of the River on Camino De La Reina and is not diverted to the sanitary sewer system during dry weather. It collects runoff from the low part of Camino De La Reina under the freeway and some of the surrounding businesses. It may discharge to the River when the groundwater table is high even during dry weather. Sampling site T3D (Avenida del Rio) was located just downstream to monitor potential impact on water quality from the station, as discussed above. For general storm drain pump station operation and maintenance practices refer to Section 8.2.6.

### 7.2.2 Outfalls and Discharges

On July 16, 2003 field crews inspected eight outfalls along the San Diego River from Fashion Valley Road to the Highway 163. Samples were collected from two of these outfalls and are discussed below. The remaining six outfalls were dry.

### 7.2.3 Site SD-FV-1

This site was located on the north bank of the San Diego River, adjacent to the Fashion Valley Transit Center along Riverwalk Drive. Samples were collected at the base of the outfall structure (Figure 7-4). The structure consists of a forty-eight inch pipe and a twenty-four inch pipe. Flap gates cover both outfalls. The twenty-four inch outfall was flowing and a sample was collected. An additional sample was collected on July 21, 2003. The results are presented in Table 7-6.

**Figure 7-4. Storm drain outfall at Site SD-FV-1.**

**Table 7-6. Bacterial indicator results for SD-FV-1.**

| Dates | Total Coliform (MPN/100 mL) | Fecal Coliform (MPN/100 mL) | *Enterococcus* (MPN/100 mL) |
|---|---|---|---|
| July 16, 2003 | 1,300 | <20 | <10 |
| July 21, 2003 | 230 | <20 | <10 |

### 7.2.4 Site SD-FV-2

This site was located on the south bank of the River, west of Avenida Del Rio. The outfall consists of two sixty-inch pipes. A sample was collected from the eastern pipe (see Table 7-7). This pipe had a trickle flow that drained into a small ponded area below the pipe (Figure 7-5). The discharge did not reach the river. The western pipe was dry.

**Figure 7-5. Storm drain outfall at Site SD-FV-2.**

**Table 7-7. Bacterial indicator results for SD-FV-2.**

| Date | Total Coliform (MPN/100 mL) | Fecal Coliform (MPN/100 mL) | *Enterococcus* (MPN/100 mL) |
|---|---|---|---|
| July 16, 2003 | 50,000 | 500 | 4,352 |


This five and a half mile long segment of the River is defined on the east by Fashion Valley Road and the Sports Arena Bridge on the west. On the east end the River transects the Riverwalk Golf Course for approximately three and a quarter miles. Numerous hotels and residential neighborhoods make up the remaining land uses in this segment of the River. At the west end of this segment, the River widens significantly and is slightly brackish and eventually becomes saline.

## 8.1 Water Quality and Potential Sources of Impairment by Site

This segment of the River is the location of four sampling stations (Table 8-1).

**Table 8-1. Site description and geographic coordinates.**

| River Site # | Site Description | Lat.[1] | Long.[1] |
|---|---|---|---|
| T3B | Riverwalk Golf Course – East Cart Bridge | 32 45.865 | 117 10.529 |
| T3A | Riverwalk Golf Course – West Cart Bridge | 32 45.721 | 117 10.853 |
| T3 | South of the YMCA off Friars Road | 32 45.683 | 117 11.845 |
| T2 | Just west of Interstate 5 at Friars Road | 32 45.663 | 117 12.451 |

[1] GPS coordinates are in degree minute decimal format (DD MM.MMM), NAD 83.

### 8.1.1 Riverwalk Golf Course East (T3B)

This site was located on the Riverwalk Golf Course property at the eastern cart path bridge (Figure 8-1). The Riverwalk Golf Course East (T3B) site represents the upstream location and is located approximately a quarter of a mile downstream of the station T3C at Fashion Valley Road. The site was sampled on the north (T3B-N) and south (T3B-S) edges of the River which generally flowed slowly in this flat area. As shown in Figure 8-2, the River was adjacent to the landscaped golf course with dirt banks and vegetation. Sampling at this site was not performed during night hours.

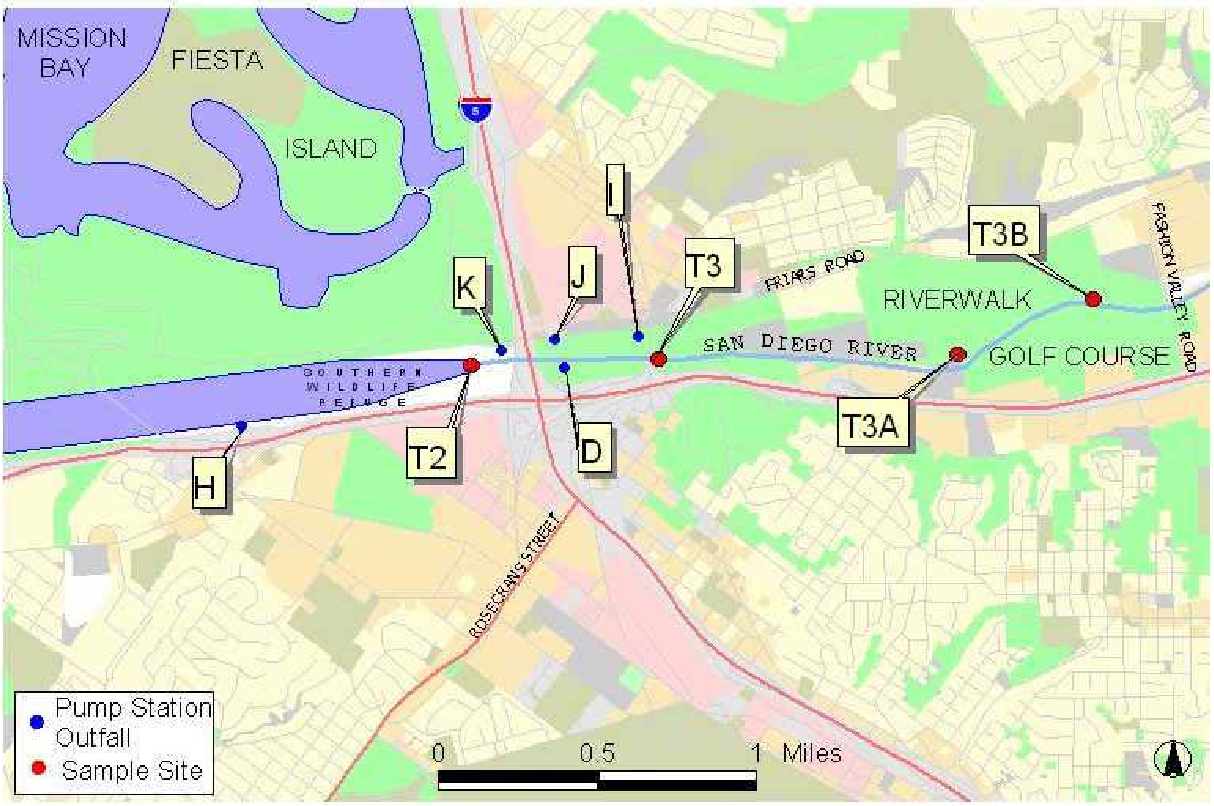



**Figure 8-1. Sampling sites.**

<u>Water Quality Results and Potential Sources</u>

This site was sampled as part of the Chronic Input Investigations Study. Results for basic chemical and physical measurements included pH which ranged from 7.40 to 8.35 and temperature recorded between 24.5 and 32.3$^0$C.

**Figure 8-2. Sampling at Riverwalk Golf Course (T3B).**

This site was sampled on 16 different days from April 28 through August 24, 2003 for bacterial indicators; total coliform levels ranged from 230 to 90,000 MPN/100 mL with a geometric mean for all data of 3,721 MPN/100 mL. Fecal coliform ranged from 20 to 50,000 MPN/100 mL with a geometric mean of 595 MPN/100 mL. *Enterococcus* ranged from non-detect to greater than 24,196 MPN/100 mL (July 21, 2003). The geometric mean for *Enterococcus* is 45 MPN/100 mL. A summary is shown on Table 8-2 and all data can be found in Appendix B.

**Table 8-2. Bacterial indicator results for the Riverwalk Golf Course East (T3B) site.**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | April 28 – August 24, 2003 | 3,721 | 230 - 90,000 |
| Fecal coliform | April 28 – August 24, 2003 | 595 | 20 - 50,000 |
| *Enterococcus* | April 28 – August 24, 2003 | 45 | <10 - >24,196 |

AB411 criteria were exceeded on 14 out of 16 days for any of the indicators. Additional information on AB411 criteria is shown in Table 8-3.

**Table 8-3. Summary of Riverwalk Golf Course East (T3B) sampling site indicator bacteria compared to AB411 criteria.**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T3B | No. of Samples | 32 | 32 | 32 |
| | No. of Tests exceeding AB411 criteria | 15 (46.9%) | 17 (53.1%) | 6 (18.7%) |
| | No. of Samples Exceeding Any AB411 criteria | 14 (87.5%) | | |
| | No. of Sample Days | 16 | | |
| | No. of Days Exceeding AB411 criteria | 14 (87.5%) | | |

The high temperature reading of 32.3$^0$C and pH of 8.35 were taken in extremely shallow water on July 24, 2003 which may explain the uncharacteristic results.

Bacteria levels at the Riverwalk Golf Course East (T3B) site were fairly high; explanations include: 1) the influence from the high levels of all bacteria types found at the upstream site at Fashion Valley Road (T3C); and 2) contributions from birds, sediments and landscape runoff from the area surrounding the Riverwalk Golf Course East (T3B) site.

Total coliform levels at the Riverwalk Golf Course East (T3B) site are the second highest of all the River transects with a geometric mean of 3,721 MPN/100 mL (Table 8-2). The highest levels were found at the Fashion Valley Road (T3C) site with a geometric mean of 3,967 MPN/100 mL which was just about a quarter of a mile upstream.

The geometric mean for fecal coliform at the Riverwalk Golf Course East (T3B) site was 595 MPN/100 mL while upstream at Fashion Valley Road (T3C) site was 910 MPN/100 mL. *Enterococcus* was similar with a geometric mean of 45 MPN/100 mL at the Riverwalk Golf Course East (T3B) site and 76 MPN/100 mL at Fashion Valley Road (T3C).

The repeated measures ANOVA test does not indicate that there was a significant difference in the bacteria levels for all three indicators between the Riverwalk Golf Course (T3B) site and the Fashion Valley Road (T3C).

### *8.1.2 Riverwalk Golf Course West (T3A)*

<u>Site Description</u>
The Riverwalk Golf Course (T3A) site was also located on the Riverwalk Golf Course at the western cart path bridge. Sampling was conducted on both the north and south sides of the River, labeled T3A-N and T3A-S respectively. Sampling at this site was not performed during night hours.

The site was generally found to have very slow moving water and as evident in Figure 8-3 was observed to have substantial algae on the surface. Birds were frequently observed on numerous visits.

**Figure 8-3. Sampling site T3A at Riverwalk Golf Course.**

<u>Water Quality Results and Potential Sources</u>
This was the second Riverwalk Golf Course site sampled as part of the Chronic Input Investigations Study and located approximately a third of a mile downstream of the Riverwalk Golf Course East (T3B) site discussed above. Access to perform sampling was not possible in the late evening and at night.

Results for basic chemical and physical measurements at this location were pH recorded between 7.53 and 7.99 and temperature between 25.0 and 28.3$^{0}$C on three separate dates between July 24 and August 23, 2003.

This site was sampled for bacteria on 16 different days from April 28 through August 24, 2003. Bacterial indicators results at this site are summarized in Table 8-4. The total coliform range was 230 to 17,000 MPN/100 mL; fecal coliform was non-detect to 7,000 MPN/100 mL; and *Enterococcus* from non-detect to 109 MPN/100 mL. The geometric means for each of the three indicators were 2,990 MPN/100 mL for total coliform, 281 MPN/100 mL for fecal coliform and 27 MPN/100 mL for *Enterococcus*.

**Table 8-4. Bacterial indicator results for Riverwalk Golf Course West (T3A) site.**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | April 28 – August 24, 2003 | 2,990 | 230 - 17,000 |
| Fecal coliform | April 28 – August 24, 2003 | 281 | <20 - 7,000 |
| *Enterococcus* | April 28 – August 24, 2003 | 27 | <10 - 109 |

AB411 criteria were exceeded on 10 out of 16 days for any of the indicators. Additional information on AB411 criteria is shown in Table 8-5.

**Table 8-5. Summary of the Riverwalk Golf Course West (T3A) sampling site indicator bacteria compared to AB411 criteria.**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T3A | No. of Samples | 32 | 32 | 31 |
| | No. of Tests exceeding AB411 criteria | 14 (43.7%) | 10 (31.2%) | 3 (9.7%) |
| | No. of Samples Exceeding Any AB411 criteria | 10 (62.5%) | | |
| | No. of Sample Days | 16 | | |
| | No. of Days Exceeding AB411 criteria | 10 (62.5%) | | |

The upstream transect, Riverwalk Golf Course East (T3B) described in Section 8.1.1, was noted to have bacterial levels that were high when compared to other transects, but it was reasoned that inputs further upstream at the Fashion Valley Road (T3C) site may be the cause of the high levels at T3B. The same appears to be the case at Riverwalk Golf Course West (T3A) where high levels continue to decrease. The geometric mean for total coliform drops from 3,721 MPN/100 mL to 2,990 MPN/100 mL between the two golf course sites (T3B and T3A). The drop in the number of exceedances also reflect minor improvements in total coliform levels from 15 out of 32 (46.9%) at Riverwalk Golf Course East (T3B) to 14 out of 32 (43.7%) at Riverwalk Golf Course West (T3A).

The trend is similar for fecal coliform with a reduction from a geometric mean of 595 MPN/100 mL at the Riverwalk Golf Course East (T3B) site to 282 MPN/100 mL at the Riverwalk Golf Course West (T3A) site. The number of exceedances for fecal coliform went from 17 out of 32

(53.1%) at Riverwalk Golf Course East (T3B) to 10 out of 32 (31.2%) at Riverwalk Golf Course West (T3A).

*Enterococcus* levels were also shown to decrease, similarly to fecal coliform, between stations T3B and T3A. The geometric mean reflects the reduction from the Riverwalk Golf Course East (T3B) site with 45 MPN/100 mL to the Riverwalk Golf Course West (T3A) site with 27 MPN/100 mL. The number of exceedances of *Enterococcus* was reduced in half from 18.7% at T3B to 9.7% at T3A.

The repeated measure ANOVA test indicates that there was a significant difference between the Riverwalk Golf Course East (T3B) and West (T3A) sites for all three bacteria indicators. Possible explanations for the decreases included: 1) natural bacteria die-off; 2) bactericidal effects of sunlight; 3) predation by other bacteria and protozoans. Inputs at this location may be contributing some additional bacteria, but the levels were minor compared to the upstream inputs.

A comprehensive discussion of the findings across all San Diego River transects can be found in Section 11.

### *8.1.3 Mission Valley YMCA (T3)*

<u>Site Description</u>

Transect 3 represented the last location downstream of Riverwalk Golf Course and the last station that was not influenced by seawater. The site was off a foot path on the south end of the YMCA parking lot on Friars Road and was sampled on both the north (T3-N) and south (T3-S) sides of the River (Figure 8-4). The area surrounding this location was inhabited by homeless persons. The river banks were littered with clothing, trash and other debris, but the water in the River was clear and free from floating debris. The River was approximately 2 feet deep and flowed slowly at this transect.

**Figure 8-4. Sampling site T3 at the YMCA.**

<u>Water Quality Results and Potential Sources</u>

This site was one of the original six used in the initial investigations conducted at the onset of the project and the Chronic Input Investigations initiated in the spring. Results from both are provided below.

<u>Initial Investigations</u>

The samples for bacterial analyses and chemical/physical water quality measurements were taken at five stations equally spaced along the length of the transect (sampling and testing methods are found in Appendix B). Sample times were 0800 hrs, 1200 hrs, and 1600 hrs. A total of 30 samples were collected during the two days.

A summary of the chemical and physical water quality measurements included pH, temperature, conductivity, ammonia and total suspended solids are shown in Table 8-6. The results from the October 2002 samples do not show evidence of potential sources (i.e. high ammonia indicating a leaking sewer line). The results of all measurements are found in Appendix B.

**Table 8-6. Chemical and physical measurements at the Mission Valley YMCA site in October 2002.**

| Parameter | Dates | Range |
|---|---|---|
| pH | October 14 and 18, 2002 | 7.25 – 7.76 |
| Temperature | October 14 and 18, 2002 | 17.2- 20.9°C |
| Conductivity | October 14 and 18, 2002 | 3.55 – 4.23mS/cm |
| Ammonia | October 14 and 18, 2002 | <1 mg/L |
| Total Suspended Solids | October 14 and 18, 2002 | <1 – 1.3 mg/L |

Corresponding bacteria analysis results from samples collected as part of the initial investigations are shown in Table 8-7. The complete dataset can be found in Appendix B.

**Table 8-7. Bacterial indicator results at the Mission Valley YMCA (T3) site in October 2002.**

| Parameter | Dates | Range (MPN/100 mL) |
|---|---|---|
| Total coliform | October 14 and 18, 2002 | 20 – 5,000 |
| Fecal coliform | October 14 and 18, 2002 | <20 - 130 |
| *Enterococcus* | October 14 and 18, 2002 | <10 - 73 |

One sample collected on October 14, 2002 exceeded AB411 criteria for total coliform based on the limit of 1,000 MPN/100 mL with >10% of fecal coliform. The total coliform level was 1,100 MPN/100 mL and fecal coliform 230 MPN/100 mL. This was the only sample exceeding AB411 criteria out of 30 samples collected during two days of sampling.

<u>Chronic Input Investigations</u>

The Chronic Input Investigations at the Mission Valley YMCA (T3) site were conducted from April 9 through August 24, 2003 and included water quality samples for physical, chemical and bacteria analysis. The results for basic water quality measurements taken from July 29 through August 9, 2003 were 1.0 parts per thousand for salinity (measured on July 24, 2003 only); pH from 7.58 to 7.84; and temperature from 24.3-25.8$^0$C.

Bacteria data collected from April 9 through August 24, 2003 are summarized in Table 8-8 and shows total coliform ranged from 110 to 3,000 MPN/100 mL; fecal coliform from less than 20 to 2,300 MPN/100 mL; and *Enterococcus* from less than 10 to 41 MPN/100 mL during the period. The geometric means for the total coliform, fecal coliform and *Enterococcus* were 443 MPN/100 mL; 37 MPN/100 mL; and 13 MPN/100 mL respectively.

The number of exceedances of AB411 criteria were greatly reduced at the Mission Valley YMCA (T3) site to one for total coliform on May 30, 2003. There were two exceedances for fecal coliform at sites T3-N and T3-S on May 30, 2003. *Enterococcus* had no exceedances (Table 8-8). The reduction in exceedances is important when compared to sites located upstream.

**Table 8-8. Bacterial indicator results for the Mission Valley YMCA (T3) site.**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | April 9 – August 24, 2003 | 443 | 110 - 3,000 |
| Fecal coliform | April 9 – August 24, 2003 | 37 | <20 – 2,300 |
| *Enterococcus* | April 9 – August 24, 2003 | 13 | <10 - 41 |

AB411 criteria were exceeded only 1 out of 27 days or 3.7% of the time for any of the indicators. Additional information on AB411 criteria is shown in Table 8-9.

**Table 8-9. Summary of the Mission Valley YMCA (T3) sampling site indicator bacteria compared to AB411 criteria.**

<table>
<tr><th>Site</th><th></th><th>Total Coliform</th><th>Fecal Coliform</th><th>Enterococcus</th></tr>
<tr><td rowspan="5">T3</td><td>No. of Samples</td><td>54</td><td>54</td><td>54</td></tr>
<tr><td>No. of Tests exceeding AB411 criteria</td><td>1 (1.85%)</td><td>2 (3.7%)</td><td>0 (0%)</td></tr>
<tr><td>No. of Samples Exceeding Any AB411 criteria</td><td colspan="3">1 (3.7%)</td></tr>
<tr><td>No. of Sample Days</td><td colspan="3">27</td></tr>
<tr><td>No. of Days Exceeding AB411 criteria</td><td colspan="3">1(3.7%)</td></tr>
</table>

The bacteria reduction trend described in the previous section between Riverwalk Golf Course East (T3B) and West (T3A) continued at the Mission Valley YMCA (T3) site. The geometric mean for total coliform is 443 MPN/100 mL at T3 which shows a significant difference (reduction) compared to the previous three stations upstream at Riverwalk Golf Course West (T3A) site with 2,990 MPN/100 mL; the Riverwalk Golf Course East (T3B) site with 3,721 MPN/100 mL; and the Fashion Valley Road (T3C) site with 3,967 MPN/100 mL as shown in Figure 8-6.

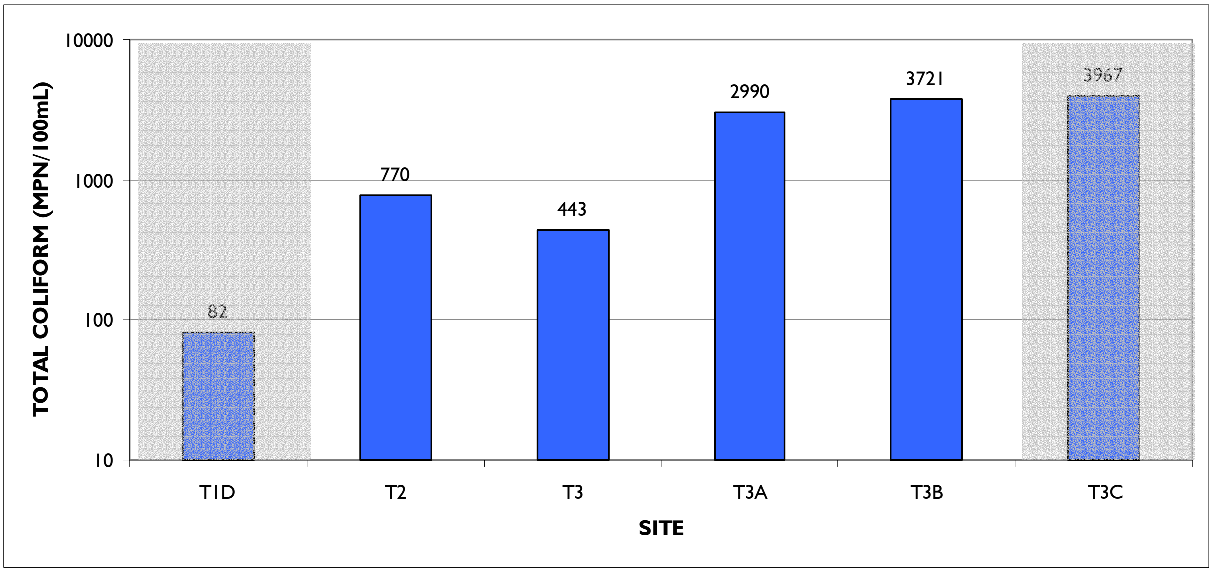



**Figure 8-6. Geometric mean of total coliforms by site (Fashion Valley to Mission Bay Bridge segment).**

Fecal coliform geometric mean data also show the reduction at the Mission Valley YMCA (T3) site with 37 MPN/100 mL which is significantly different (by the repeated measures ANOVA test) from the Riverwalk Golf Course West (T3A) site with 281 MPN/100 mL; the Riverwalk Golf Course East (T3B) with 595 MPN/100 mL; and Mission Valley YMCA (T3C) site with 910 MPN/100 mL as shown graphically in Figure 8-7.


**Figure 8-7. Geometric mean of fecal coliforms by site (Fashion Valley to Mission Bay Bridge segment).**

The geometric mean for *Enterococcus* at the Mission Valley YMCA (T3) with 13 MPN/100 mL is significantly different (ANOVA test) from *Enterococcus* levels at the Riverwalk Golf Course West (T3A) site with 27 MPN/100 mL; the Riverwalk Golf Course East (T3B) site with 45 MPN/100 mL; and the Mission Valley YMCA (T3C) site with 76 MPN/100 mL as shown in Figure 8-8.

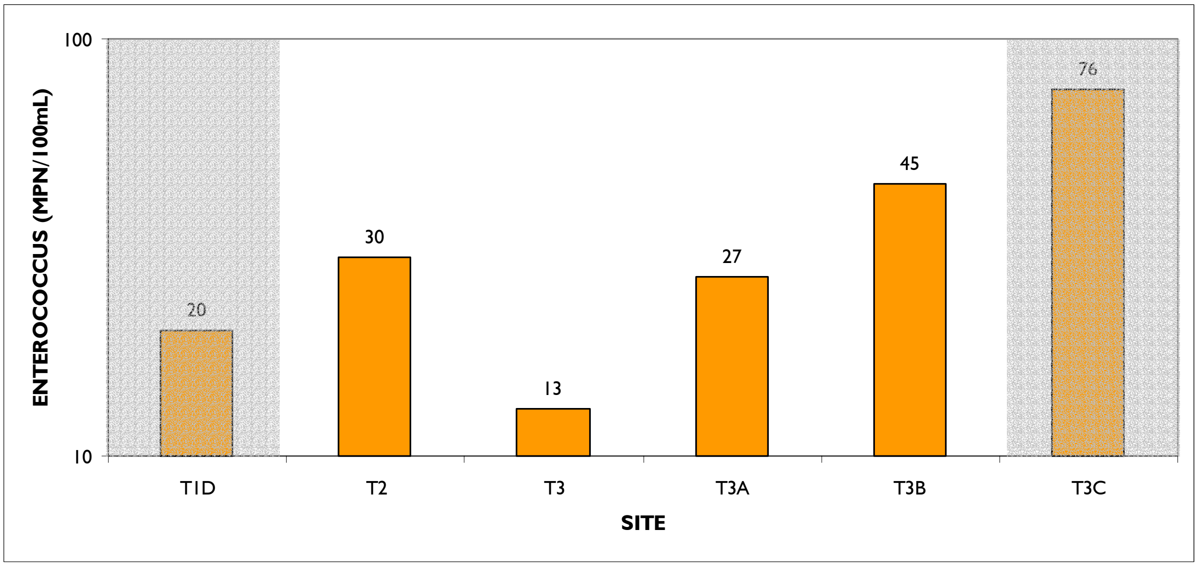



**Figure 8-8. Geometric mean of *Enterococcus* by site (Fashion Valley to Mission Bay Bridge segment).**

### *8.1.4 Interstate 5 (T2)*

Site Description

This transect was located just west of Interstate-5 within the Southern Wildlife Refuge and was sampled by kayak on only a few occasions (Figure 8-5). The majority of the sampling took place from the riprap on the north bank (T2-N). This transect is the first with saline conditions.

**Figure 8-5. Sampling site T2.**

Water Quality Results and Potential Sources

This site was one of the original six used in the initial investigations conducted at the onset of the project and the Chronic Input Investigations initiated in the spring. Results from both are provided below.

Initial investigations

This site was sampled in October 2002 as part of the initial investigations. Results for basic chemical and physical measurements are shown in Table 8-10. A full listing of all sample results is shown in Appendix B.

**Table 8-10. Chemical and physical measurements at the Interstate 5 (T2) site in October 2002.**

| Parameter | Dates | Range |
|---|---|---|
| pH | October 14 and 18, 2002 | 7.35 – 7.93 |
| Temperature | October 14 and 18, 2002 | 18.1- 22.2°C |
| Conductivity | October 14 and 18, 2002 | 25.00 – 30.74 mS/cm |
| Ammonia | October 14 and 18, 2002 | <1 mg/L |
| Total Suspended Solids | October 14 and 18, 2002 | 2.1 – 3.9 mg/L |

None of the fifteen samples collected on October 14, 2002 exceeded any of the three bacterial indicators. On October 18, 2002 total coliforms were exceeded six times for samples collected throughout the day (0800, 1200 and 1600 hours); fecal coliform was also exceeded six times; and *Enterococcus* was only exceeded once in the morning with a result of 135 MPN/100 mL. The exceedances of AB411 criteria were triggered by the total coliform level being over 1,000 MPN/100 mL when the fecal coliform was >10% of the total. The maximum numbers, as seen in Table 8-11, were not generally high at 1,400 MPN/100 mL. The ratios of total to fecal coliform results were generally 1:1 or 2:1 when the total coliform exceeded the 1,000 MPN/100 mL criteria.

**Table 8-11. Bacterial indicator results at the Interstate 5 (T2) site in October 2002.**

| Parameter | Dates | Range (MPN/100 mL) |
|---|---|---|
| Total coliform | October 14 and 18, 2002 | <20 – 1,400 |
| Fecal coliform | October 14 and 18, 2002 | <20 – 1,400 |
| *Enterococcus* | October 14 and 18, 2002 | <10 - 135 |

Chronic Input Investigations

The Chronic Input Investigations at the Interstate 5 site (T2) were conducted from April 10 through August 24, 2003 and included water quality samples for physical, chemical and bacteria analysis. The results for water quality are shown in Table 8-12.

**Table 8-12. Chemical and physical measurements at the Interstate 5 (T2) site in 2003.**

| Parameter | Dates | Range |
|---|---|---|
| pH | July 24 – August 9, 2003 | 7.91 – 8.58 |
| Temperature ($^0$C) | July 24 – August 9, 2003 | 25.5 – 29.1 |
| Salinity (ppt) | June 9 – August 24, 2003 | 5-18 |

A total of 24 sampling events were conducted at the Interstate 5 (T2) site from April 10 – August 24, 2003 for bacteria testing. Bacteria data is summarized in Table 8-13 which shows total coliform ranged from 20 to 5,000 MPN/100 mL; fecal coliform from less than 20 to 1,700 MPN/100 mL; and *Enterococcus* from less than 10 to 282 MPN/100 mL during the period sampled. The geometric means for total coliform, fecal coliform and *Enterococcus* were 770 MPN/100 mL; 257 MPN/100 mL; and 30 MPN/100 mL, respectively.

**Table 8-13. Bacterial indicator results for the Interstate 5 (T2) site.**

| Parameter | Dates | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total coliform | April 10 – August 24, 2003 | 770 | 20 – 5,000 |
| Fecal coliform | April 10 – August 24, 2003 | 257 | <20 – 1,700 |
| *Enterococcus* | April 10 – August 24, 2003 | 30 | <10 - 282 |

AB411 criteria were exceeded on 11 out of 24 days sampled for any of the indicators. Additional information on AB411 criteria is shown in Table 8-14.

**Table 8-14. Summary of Interstate 5 (T2) sampling site indicator bacteria compared to AB411 criteria.**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T2 | No. of Samples | 48 | 48 | 48 |
| | No. of Tests exceeding AB411 criteria | 7 (14.6%) | 9 (18.7%) | 7 (14.6%) |
| | No. of Samples Exceeding Any AB411 criteria | 11 (45.8 %) | | |
| | No. of Sample Days | 24 | | |
| | No. of Days Exceeding AB411 criteria | 11 (45.8%) | | |

Total coliform levels at the Interstate 5 (T2) site are significantly higher than the levels at the upstream location at the Mission Valley YMCA (T3), and lower than Riverwalk Golf Course West (T3A), Riverwalk Golf Course East (T3B), Fashion Valley Road (T3C) and Avenida del Rio (T3D) discussed earlier (Figure 8-6). The total coliform levels at the Interstate 5 (T2) site increase as shown by the geometric mean at 770 MPN/100 mL when compared to the Mission Valley YMCA (T3) site at 443 MPN/100 mL. The station located downstream at Sunset Cliffs Blvd (T1D) is also significantly lower.

Fecal coliforms were also significantly different (ANOVA) at Interstate 5 (T2) with 257 MPN/100 mL compared to the Mission Valley YMCA (T3) site with 37 MPN/100 mL (Figure 8-7). Lastly, *Enterococcus* was also significantly different with 30 MPN/100 mL at Interstate 5 (T2) compared to 13 MPN/100 mL at the Mission Valley YMCA (T3) site (Figure 8-8).

The increase in geometric mean concentrations for all three bacterial indicators at the Interstate 5 (T2) site (Figure 8-6 to 8-8) is explained by the contributions made from Pump Station D located approximately 400 yards upstream and the large number of homeless and transient people that inhabit the wide and sandy riverbed between the sites at the Mission Valley YMCA (T3) and Interstate 5 (T2).

## 8.2 Storm Drain Infrastructure/Diversion System

This segment of the River includes five storm drain pump stations (I, J, D, K and H) and numerous outfalls as described in detail below. Out of the five pump stations only H has diversion to the sanitary sewer system.

### 8.2.1 Pump Station I

This pump station is located on the north bank of the River just west of Morena Boulevard at 5000 Friars Road. It discharges runoff and storm water from Friars Road. It is generally does not have flow during dry weather periods.

### 8.2.2 Pump Station J

Pump Station J is located on the north bank of the River at 4800 Friars Road (or just east of Pacific Highway). It collects and discharges runoff from Friars Road and Anna Avenue. This pump station is observed to have occasional flow during dry weather periods.

### 8.2.3 Pump Station D

Pump station D is the largest pump station and it does not have diversion to the sanitary sewer. Located at 3992 Rosecrans Street just north of the San Diego Trolley station at the foot of Old Town, this very large storm drain system pump station has been investigated on several occasions to determine how the discharge influences water quality in San Diego River. It includes storm water pumped from Pump Station A (at 3780 Witherby Street). The 72" outfall for Pump Station D is located on the south bank of the River between Pacific Hwy and the Santa Fe Railroad tracks just north of a commercial storage business. Discharge to the River takes place as various levels are reached in the wet well that energize pumps to drain the structure.

Operational Features

Pump station D is composed of two 60 HP pumps and eight 200 HP pumps. Only the 60 HP pumps are triggered between water depth levels of 5-10 feet. The operational settings for the pumps at Pump Station D were noted from the electrical control panel as described in Table 8-15.

**Table 8-15. Pump Station D - Pump Operation Scheme.**

| Operational Step | Pump Status |
|---|---|
| 1 | No pumping if level is below 5 feet |
| 2 | At 7 feet first 60 HP pump comes on |
| 3 | At 9 feet second 60 HP pump comes on |
| 4 | At 10 ft first 200 HP pump comes on |
| 5 | At 10 ft both 60 HP pumps turn off |
| 6 | At 12, 14, 15, 16, 17, 18 and 19 ft a 200 HP pump turns on at each level |

#### 8.2.3.1 Pump Station D Investigations

The initial field investigation in November 2002 led to a decision to sample for bacterial levels in the standing water in the pump station wet well concurrent with the transect sampling in the River that was scheduled to take place on December 2, 2002. At the same time, bacteria samples would be collected in the River at points upstream and downstream of the pump station.

On December 2, 2002, four samples were collected about Pump Station D prior to a discharge event. Two samples were collected from the wet well (upper and lower 1 foot of the water column), one sample was collected upstream of the discharge point (Sample TD2) and one sample was collected downstream of Pump Station D (Sample TD1). During the discharge event, a second sample (Sample TD1B) collected at the downstream station was collected to determine if levels within the river increased as a result of discharge.

Sampling conducted at Pump Station D was repeated on January 2 and January 27, 2003. During these sampling events, samples were also collected at the outfall. Samples were not collected at the bottom of the wet well during these two inspections.

#### 8.2.3.2 Pump Station D Bacteria Results

During all three sampling events, the bacterial concentrations about Pump Station D showed a similar pattern. Samples collected within the wet well had high concentrations of all three bacterial indicators. Samples collected at an upstream reference site were low compared to samples collected downstream, with the exception of samples collected on December 2, 2002. On this day, the upstream samples had similar concentrations to the downstream site prior to discharge, and these elevated levels at the upstream site were likely a result of a storm event occurring within 3 days of the sampling effort. Samples collected at the downstream sample site during the discharge showed increases in bacterial levels when compared to samples collected prior to the discharge. Tables 8-16 through 8-18 present the data for all three sampling events. Figure 8-9 provides an illustration of the sample sites and reviews select data for these events.

**Table 8-16. Pump Station D Investigations, December 2, 2002.**

| Parameter (Results MPN/100 mL) | Prior to Discharge | | | | During Discharge |
|---|---|---|---|---|---|
| | Pump Station (Top) | Outfall Discharge (TD) | Upstream (TD2) | Downstream (TD1) | Downstream (TD1B) |
| Total Coliform | 800,000 | NA | 22,000 | 30,000 | 2,800,000 |
| Fecal Coliform | 2,300 | NA | 5,000 | 3,000 | 11,000 |
| *Enterococcus* | 845 | NA | 657 | 1,259 | 14,700 |

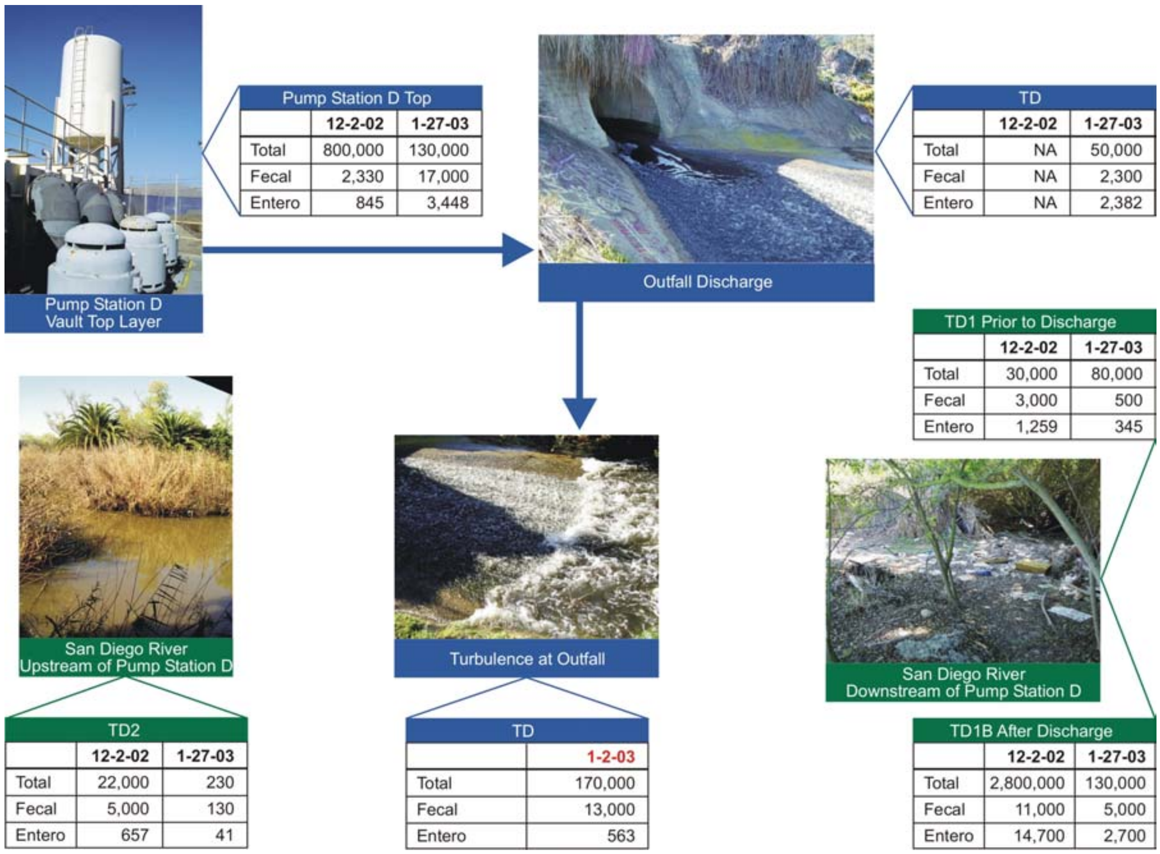
**Table 8-17. Pump Station D Investigations, January 2, 2003.**

| Parameter (Results MPN/100 mL) | Prior to Discharge | | | | During Discharge |
|---|---|---|---|---|---|
| | Pump Station (Top) | Outfall Discharge (TD) | Upstream (TD2) | Downstream (TD1) | Downstream (TD1B) |
| Total Coliform | 170,000 | 170,000 | 1,100 | 3,000 | NA |
| Fecal Coliform | 50,000 | 13,000 | 500 | 800 | NA |
| *Enterococcus* | 1,050 | 563 | 20 | 218 | NA |

**Table 8-18. Pump Station D Investigations, January 27, 2003.**

| Parameter (Results MPN/100 mL) | Prior to Discharge | | | | During Discharge |
|---|---|---|---|---|---|
| | Pump Station (Top) | Outfall Discharge (TD) | Upstream (TD2) | Downstream (TD1) | Downstream (TD1B) |
| Total Coliform | 130,000 | 50,000 | 230 | 80,000 | 80,000 |
| Fecal Coliform | 17,000 | 2,300 | 130 | 500 | 5,000 |
| *Enterococcus* | 3,448 | 2,382 | 41 | 345 | 3,130 |

The increasing levels of bacteria in the River just downstream of the pump station might be explained by the mechanics of the discharge. The discharge from the pump station created significant agitation of sediment on the River's edge at the foot of the outfall which can lead to higher observed bacterial concentrations in water samples. This agitation was the result of the force of the discharge from the pump station and the lack of energy dissipation at the outfall structure. For example, on December 2, 2002, the sample collected downstream of the pump station outfall (TD1) prior to discharge had concentrations of total coliform at 30,000 MPN/100 mL, fecal coliform at 3,000 MPN/100 mL and *Enterococcus* at 1,259 MPN/100 mL. During the discharge event, the bacteria levels were found to be significantly higher at this station, with 280,000 MPN/100 mL total coliforms, 11,000 MPN/100 mL fecal coliforms and 14,700 MPN/100 mL *Enterococcus*. The samples collected downstream of the Pump Station during the discharge events were observed to be light brown to amber in color, again, most likely due to increased particulate matter re-suspended from the river bottom.




| Pump Station D Top | 12-2-02 | 1-27-03 |
|---|---|---|
| Total | 800,000 | 130,000 |
| Fecal | 2,330 | 17,000 |
| Entero | 845 | 3,448 |

| TD | 12-2-02 | 1-27-03 |
|---|---|---|
| Total | NA | 50,000 |
| Fecal | NA | 2,300 |
| Entero | NA | 2,382 |

| TD1 Prior to Discharge | 12-2-02 | 1-27-03 |
|---|---|---|
| Total | 30,000 | 80,000 |
| Fecal | 3,000 | 500 |
| Entero | 1,259 | 345 |

| TD2 | 12-2-02 | 1-27-03 |
|---|---|---|
| Total | 22,000 | 230 |
| Fecal | 5,000 | 130 |
| Entero | 657 | 41 |

| TD | 1-2-03 |
|---|---|
| Total | 170,000 |
| Fecal | 13,000 |
| Entero | 563 |

| TD1B After Discharge | 12-2-02 | 1-27-03 |
|---|---|---|
| Total | 2,800,000 | 130,000 |
| Fecal | 11,000 | 5,000 |
| Entero | 14,700 | 2,700 |

**Figure 8-9. Partial Summary of data collected at Pump Station D.**

### *8.2.3.3 Pump Station D – San Diego River Sediment and Miscellaneous Samples*

Water samples were collected prior to discharge (TD1) and after/during discharge (TD1B) at the downstream sampling point to determine the change in suspended solids levels. The results show that total suspended solids increased from 2.2 to 130.9 mg/L after the discharge from the pump station took place.

Sediment samples were collected from the river bottom near the discharge from Pump Station D to determine the bacteria levels in the soil. Total organic carbon and grain size were also measured to assist in characterizing the sediment (Table 8-19).

This information combined with the data from the sediment analysis confirms that the re-suspension of sediment from the River bottom contributes to a small decrease in water quality downstream of the outfall.

**Table 8-19. San Diego River sediment test results downstream of Pump Station D outfall (January 27, 2003).**

| Parameter Tested | Level |
|---|---|
| Total Coliform | 1,385 organisms/g-dry weight |
| Fecal Coliform | 15 organisms/g-dry weight |
| Total Organic Carbon | 4.1 % |
| Grain Size Analysis | 68.4 % sand; 20.5% silt and 10.6% clay. |

### *8.2.4 Pump Station K*

Located at 4500 Friars Road on the north bank of the River (just west of the south bound off ramp to Rosecrans Street from Interstate 5 south), the wet well for this pump station only collects runoff from Friars Road and discharges it to the River. During the dry weather period this pump station and the outfall are generally observed to be dry which confirms that other sources are unlikely.

### *8.2.5 Outfall 3 at Pump Station H*

This outfall is the location of Storm Station H which is approximately midway between the Mission Bay Drive Bridge and Interstate 5. The pump station is on the trail/access road on the south levy of the River. Pump Station H is designed to pump storm water over the river bank and to San Diego River. The outfall structure contains several small outlets (six 18" concrete pipes and one 6" C.I. pipe) and a steep sloped concrete spillway to the River.

Urban runoff from the Sports Arena area (including Hancock Street) is collected at Pump Station H and diverted to the sanitary sewer (Figure 8-10). The interceptor system (IPS 10 or I-10) consists of a wet well and pump station located just south of Pump Station H. The diversion is manually operated. Flows are pumped south under Interstate 8, east to Channel Way, and south on Hancock Street to a 27 inch sewer main located in Sports Arena Boulevard. The end of the diversion line is a sewer manhole in Sports Arena Blvd and Hancock Street.

**Figure 8-10. Pump Station H.**

### *8.2.6 General Pump Station Operation and Maintenance*

Storm Drain System pump stations along San Diego River are operated and maintained by the Streets Division of the Transportation Department of the City of San Diego. The maintenance schedule for the pump stations was enhanced in August 2002 with an increase in frequency of cleaning and maintenance. Prior to August 2002 only Pump Station H was routinely cleaned, and the remaining stations were cleaned as needed. The revised schedule is designed to rotate cleaning of all the stations at a set frequency. Pump Stations D and H are cleaned every three weeks. Pump stations A, I and J are rotated for cleaning every nine weeks (along with Mission Bay pump stations). Pump Stations K and E are cleaned as needed.

Prior to the fall of 2002 a pump station wet well would be drained and flushed with water directly to the River as part of the cleaning operation. In 2002 that practice was modified and now each time a pump station is cleaned the runoff in the wet well and any wash water from the cleaning operation is discharged to the sanitary sewer or collected with a Vactor truck for eventual disposal at one of the San Diego Metro Wastewater Pump Stations.

### *8.2.7 Riverwalk Golf Course Outfalls*

Numerous drainage pipes constructed of 6-inch PVC pipe were located throughout the golf course and contribute irrigation overflow to the River (e.g., Figure 8-2).

### *8.2.8 Outfalls 2 and 1*

These two outfalls did not qualify for diversion in 1987. Outfall 2 was the outlet for a 42-inch reinforced concrete storm drain line that did not have any sewer lines in the drainage area. The drainage area was south of Interstate 8 and west of Interstate 5. The outfall was located on the south bank of the River. Outfall 1 was an 18-inch corrugated metal pipe outlet on the north bank of the River on Sea World Drive in a drainage area does not have sanitary sewer lines.

# Sports Arena Bridge to Dog Beach

**SECTION 9**


This segment of the River comprises the western portion of the Southern Wildlife Refuge and Dog Beach and is approximately 1.5 miles in length. This portion of the River is commonly known as the San Diego River Flood Control Channel and more closely resembles a tidal estuary than a river. The river banks are riprap with ruderal vegetation. There is no significant source of leaf litter along the river banks. With the exception of the bridge structures, there are no shaded areas of the river. East of Dog Beach the River is approximately 0.25 miles wide at high tide, and becomes channelized at low tides with mudflats exposed. Along the northern boundaries of Dog Beach, the River width varies with tide height and is typically only 50 feet wide.

Dog Beach was formed following the construction of the jetty between the entrance to Mission Bay and the San Diego River. A combination of ocean currents, tidal processes, river flow and discharges from Outfalls 13 and 14 have shaped Dog Beach. It has also developed a spit extending east, upstream into the River. This peninsula-shaped area is confined by the Pacific Ocean on the west, the San Diego River Flood Control Channel on the north and Dog Beach parking lot on the south. Extensive mudflats exposed at lower tides bound the beach area to the east. This large, flat beach area is approximately 0.25 miles wide (north to south) and 0.5 miles long (west to east).

Dog Beach was one of the first leash-free beaches in the United States and has become the icon of Ocean Beach. It is also a popular tourist destination.

This segment of the River contained multiple permanent sampling sites (Figure 9-1). These are listed below (Table 9-1). There were several sampling sites that were dependent on field conditions, such as the eastern mudflat sediment sampling sites and kelp sampling locations; therefore, those sampling coordinates are not presented here, but can be found in Appendix B. The sampling sites located on Dog Beach were dependant on tide height; therefore, GPS coordinates presented here are an approximate representation of actual sample location.


**Figure 9-1. Sampling sites.**

**Table 9-1. Site description and geographic coordinates.**

| River Site # | Site Description | Lat.[1] | Long.[1] |
|---|---|---|---|
| T1A | At base of Storm Drain Outfalls 13 and 14 | 32° 45.305 | 117° 14.761 |
| T1B | At base of Storm Drain Outfall 12; Robb Field West | 32° 45.343 | 117° 14.532 |
| T1C | At base of Storm Drain Outfall 11; Robb Field East | 32° 45.368 | 117° 14.309 |
| T1D-N | North station on transect at Sunset Cliffs Blvd. Bridge | 32° 45.532 | 117° 14.105 |
| T1D-C | Central station on transect at Sunset Cliffs Blvd. Bridge | 32° 45.445 | 117° 14.116 |
| T1D-S | South station on transect at Sunset Cliffs Blvd. Bridge | 32° 45.386 | 117° 14.145 |
| DB1 | 75 feet south of point bar (DEH AB411 Sample Site) | 32° 45.303 | 117° 15.156 |
| DB2 | At tip of point bar | 32° 45.330 | 117° 15.172 |
| DB3 | Western end of spillway in SDR Jetty | 32° 45.397 | 117° 15.063 |
| DB4 | Middle of spillway in SDR Jetty | 32° 45.397 | 117° 14.986 |
| DB5 | Eastern end of spillway in SDR Jetty | 32° 45.405 | 117° 14.854 |
| DB6 | Directly North of Robb Field baseball diamonds | 32° 45.416 | 117° 14.698 |
| DB7 | Southeastern point of Dog Beach | 32° 45.340 | 117° 14.555 |
| DB8 | Eastern end of Dog Beach, south central | 32° 45.350 | 117° 14.491 |
| DB9 | Eastern end of Dog Beach, north central | 32° 45.422 | 117° 14.600 |

[1] GPS coordinates are in Degrees Decimal Minute format (DD MM.MMM), NAD 83.

## 9.1 Water Quality and Potential Sources of Impairments by Site

### 9.1.1 Sunset Cliffs Blvd. Bridge (Transect T1D)

**Figure 9-2. Sampling site T1D.**

Site Description

This site was located along the west side of Sunset Cliffs Blvd. Bridge (Figure 9-2). Multiple stations were located across the length of the River at this site. Sampling stations were accessed by kayak. Water depths were influenced by tidal stage. At low tides, depths were less than 2 feet and eelgrass was predominant at the surface of the water. Dependent on tidal stage, the flow was either upstream (flooding tides) or downstream (ebbing tides). Shorebirds were frequently observed along the riprap on both sides of the river and at low tides on the mudflats approximately 300 feet downstream.

Water Quality

Samples at this site were collected during the initial investigations conducted during Winter 2002-03, Chronic Input Investigation Studies, Tidal Influence (24-hour) Studies and High Tide Washing Studies. Multiple samples were collected on a single day during the Tidal Influence (24-hour) Study Surveys. Appendix B presents all sample results in tabular and graphical format.

At the southern sample station (Sample ID = T1D-S), 72 samples were collected on 46 days. Of these samples, 19% would have exceeded AB411 standards for any of the bacterial indicators (Table 9-2). The samples collected on December 2, 2002 followed within 72 hours of a storm event (0.50 inches of rain) and bacterial concentrations peaked at 30,000 MPN/100 mL for total coliform, 1,400 MPN/100 mL for fecal coliform and 794 MPN/100 mL for *Enterococcus*. Sampling conducted during dry-weather conditions showed bacterial concentrations ranged from non-detect to 1,700 MPN/100 mL for total and fecal coliforms, and 216 MPN/100 mL for *Enterococcus* (Table 9-3).

**Table 9-2. AB411 exceedances summary chart for Sunset Cliffs Blvd. Bridge South (T1D-S).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T1D-S | No. of Samples | 72 | 72 | 72 |
| | No. of Samples exceed AB411 criteria | 4 (5.6%) | 7 (9.7%) | 7 (9.7%) |
| | No. of Samples Exceeding Any AB411 criteria | 14 (19.4%) | | |
| | No. of Sample Days | 46 | | |
| | No. of Days Exceeding AB411 criteria | 12 (26.1%) | | |

**Table 9-3. Bacterial indicator results for Sunset Cliffs Blvd. Bridge South (T1D-S).**

| Parameter | Dates Sampled | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total Coliform | October 14, 2002 – August 24, 2003 | 104 | <20 – 30,000 |
| Fecal Coliform | October 14, 2002 – August 24, 2003 | 82 | <20 – 1,700 |
| *Enterococcus* | October 14, 2002 – August 24, 2003 | 22 | <10 - 794 |

At the central sample station along this transect (Sample ID = T1D-C), 68 samples were collected on 42 days. Of these samples, 19% had bacterial concentrations that would have exceeded AB411 standards (Table 9-4). Similar to southern station (T1D-S), the greatest bacterial concentrations occurred following the November 28 - 29, 2002 storm event. Total coliforms were 8,000 MPN/100 mL, fecal coliforms were 1,300 MPN/100 mL and *Enterococcus* concentrations were 465 MPN/100 mL (Table 9-5). Dry-weather conditions indicated that the maximum bacterial concentrations were 2,300 MPN/100 mL for total coliform, 1,300 MPN/100 mL for fecal coliform and 228 MPN/100 mL for *Enterococcus*.

**Table 9-4. AB411 exceedances summary chart for Sunset Cliffs Blvd. Bridge Center (T1D-C).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T1D-C | No. of Samples | 68 | 68 | 68 |
| | No. of Samples exceed AB411 criteria | 3 (4.4%) | 9 (13.2%) | 6 (8.8%) |
| | No. of Samples Exceeding Any AB411 criteria | 13 (19.1%) | | |
| | No. of Sample Days | 42 | | |
| | No. of Days Exceeding AB411 criteria | 11 (26.2%) | | |

**Table 9-5. Bacterial indicator results for Sunset Cliffs Blvd. Bridge (T1D-C).**

| Parameter | Dates Sampled | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total Coliform | October 14, 2002 – August 24, 2003 | 105 | <20 – 8,000 |
| Fecal Coliform | October 14, 2002 – August 24, 2003 | 82 | <20 – 1,300 |
| *Enterococcus* | October 14, 2002 – August 24, 2003 | 22 | <10 - 465 |

At the northern sample station (Sample ID = T1D-N), 72 samples were collected on 46 days. In contrast to the other two stations on this transect, only 4% of all samples would have exceeded AB411 standards (Table 9-6). Again, the highest concentrations were observed following a storm event, with total coliforms peaking at 13,000 MPN/100 mL, fecal coliform at 1,700 MPN/100 mL and *Enterococcus* at 350 MPN/100 mL (Table 9-7). Sampling conducted during dry-weather conditions showed a drop in bacterial concentrations to a maximum of 500 MPN/100 mL for total coliform, 300 MPN/100 mL for fecal coliform and 134 MPN/100 mL for *Enterococcus*.

**Table 9-6. AB411 exceedances summary chart for Sunset Cliffs Blvd. Bridge North (T1D-N).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T1D-N | No. of Samples | 72 | 72 | 72 |
| | No. of Samples exceed AB411 criteria | 1 (1.4%) | 1 (1.4%) | 3 (4.2%) |
| | No. of Samples Exceeding Any AB411 criteria | 3 (4.2%) | | |
| | No. of Sample Days | 46 | | |
| | No. of Days Exceeding AB411 criteria | 3 (6.5%) | | |

**Table 9-7. Bacterial indicator results for Sunset Cliffs Blvd Bridge North (T1D-N).**

| Parameter | Dates Sampled | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total Coliform | October 14, 2002 – August 24, 2003 | 52 | <20 – 13,000 |
| Fecal Coliform | October 14, 2002 – August 24, 2003 | 40 | <20 – 1,700 |
| *Enterococcus* | October 14, 2002 – August 24, 2003 | 17 | <10 - 350 |

A statistical analyses of all data collected throughout the River showed that samples collected at Sunset Cliffs Blvd. Bridge were significantly lower (alpha = 0.05) than all upstream stations with respect to total coliform concentrations. It was also significantly lower than downstream sites at the base of Outfalls 12, 13 and 14. This site was also significantly lower than the next five upstream sites, from Interstate 5 to Fashion Valley Road for fecal coliforms and *Enterococcus*. *Enterococcus* levels at Sunset Cliffs Blvd. Bridge were also lower than levels observed in samples collected at Dog Beach, and Outfalls 12, 13, and 14.

During dry weather conditions, elevated bacterial concentrations at Sunset Cliffs Blvd. Bridge were more likely from transport from downstream sources during flooding tides than from transport from upstream locations. During flooding tides, transport of bacteria from Dog Beach, the mudflats located approximately 300 feet downstream or from Outfalls 13 and 14 was possible. At low ebbing tides, discharge from Outfalls 13 and 14 may potentially be transported to this site before mixing with the larger tidal estuary water mass. High river flow following storm events have the potential to contribute bacterial loads that may negatively impact the water quality at these sample stations, as evident in samples collected on December 2, 2002.

All three stations along the Sunset Cliffs Blvd. Bridge transect were sampled concurrently as sampling conducted on Dog Beach during the Tidal Influence (24-hour) Studies and High Tide Washing Studies. These samples were collected to determine if there were any sources of bacterial contamination coming from upstream that may be affecting water quality at Dog Beach during these studies. The results of these studies are discussed in the next section, 9.2.2.1.

### 9.1.2 Robb Field East (Transect T1C)

Site Description


**Figure 9-3. Sampling site T1C.**

This site was located at the base of a storm drain outfall at the eastern end of Robb Field, near the Robb Field Skate Park (Figure 9-3). The sampling station was accessed from the base of the riprap, and samples were collected in approximately 1 foot of water. The eastern extent of the mudflats were located across a drainage channel and exposed at low tides. Dependent on tidal stage, flow past this site varied in direction. Any potential discharge from Outfalls 13 and 14 may flow past this site at low tides before mixing with the rest of the tidal estuary. Shorebirds were frequently observed along the riprap and at low tides on the mudflats across the drainage channel from the sampling station. One homeless encampment became established during the course of this study directly behind the outfall structure. Rubbish was frequently observed.

Water Quality

Outfall 11 (T1C) was sampled 27 times on 27 days. Samples at this site were only collected during the Chronic Input Investigation Studies. Of these samples, 11% had bacterial concentrations that would have exceeded AB411 standards (Table 9-8). Bacterial concentrations ranged from non-detect for all three indicators to 800 MPN/100 mL for total coliform, 1,300 MPN/100 mL for fecal coliform and 122 MPN/100 mL for *Enterococcus* (Table 9-9). The exceedances at this site were not caused by discharge from Outfall 11. The outfall was always documented to be dry during all sampling events. Although this site was 0.4 miles upstream from Outfalls 13 and 14, discharge from these two outfalls has the ability to increase bacterial concentrations at this site during ebbing tidal flow. Appendix B presents all sample results in tabular and graphical format.

**Table 9-8. AB411 exceedances summary chart for Outfall 11 (T1C).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T1C | No. of Samples | 27 | 27 | 27 |
| | No. of Samples exceed AB411 criteria | 0 (0.0%) | 1 (3.7%) | 2 (7.4%) |
| | No. of Samples Exceeding Any AB411 criteria | 3 (11.1%) | | |
| | No. of Sample Days | 27 | | |
| | No. of Days Exceeding AB411 criteria | 3 (11.1%) | | |

**Table 9-9. Bacterial indicator results for Outfall 11 (T1C).**

| Parameter | Dates Sampled | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total Coliform | April 9 – August 24, 2003 | 110 | <20 - 800 |
| Fecal Coliform | April 9 – August 24, 2003 | 94 | <20 - 1300 |
| *Enterococcus* | April 9 – August 24, 2003 | 25 | <10 - 122 |

### *9.1.3 Robb Field West (Transect T1B)*

**Figure 9-4. Sampling site T1B.**

Site Description

This site was located at the base of a storm drain outfall at the western end of Robb Field (Figure 9-4). This site was accessed at the base of the riprap and samples were collected in water depths of varying from a few inches to 1 foot, depending on tidal stage. At low tides, the drainage channel originating just west of Outfalls 13 and 14 was as narrow as 6 feet and at high tides the drainage channel was as wide as 40 feet. Dependent on tidal stage, flow past this site varied in direction. At all tidal stages, any potential discharge from Outfalls 13 and 14 must flow past this site before mixing with the rest of the tidal estuary. Shorebirds were frequently observed along the riprap and at low tides on the mudflats across the drainage channel from the sampling station.

Water Quality

Outfall 12 (T1B) was sampled 41 times on 32 days. Samples at this site were collected during the Chronic Input Investigation Studies and Tidal Influence (24-hour) Studies. Multiple samples were collected on a single day during the Tidal Influence (24-hour) Study Surveys. Of these samples, 39% had bacterial concentrations that would have exceeded AB411 standards (Table 9-10). Bacterial concentrations ranged from non-detect for all three indicators to 17,000 MPN/100 mL for total coliform, 11,000 MPN/100 mL for fecal coliform and 743 MPN/100 mL for *Enterococcus* (Table 9-11) Similar to Outfall 11, flow was never observed to be discharged from Outfall 12 therefore, the elevated bacterial concentrations may be a result from the influence of discharge from Outfalls 13 and 14 (Site T1A) that are located approximately 0.25 miles away. Appendix B presents all sample results in tabular and graphical format.

**Table 9-10. AB411 exceedances summary chart for Outfall 12 (T1B).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T1B | No. of Samples | 41 | 41 | 40 |
| | No. of Samples exceed AB411 criteria | 6 (14.6%) | 11 (26.8%) | 12 (30.0%) |
| | No. of Samples Exceeding Any AB411 criteria | 16 (39.0%) | | |
| | No. of Sample Days | 32 | | |
| | No. of Days Exceeding AB411 criteria | 14 (43.8%) | | |

**Table 9-11. Bacterial indicator results for Outfall 12 (T1B).**

| Parameter | Dates Sampled | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total Coliform | April 9 – August 24, 2003 | 196 | <20 – 17,000 |
| Fecal Coliform | April 9 – August 24, 2003 | 139 | <20 – 11,000 |
| *Enterococcus* | April 9 – August 24, 2003 | 48 | <10 - 743 |

### *9.1.4 Outfalls 13 and 14 (Transect T1A)*

<u>Site Description</u>

This site was located at the base of Storm Drain Outfalls 13 and 14 (Figure 9-5). This site was accessed at the base of the riprap and samples were collected in water depths that varied with tidal stage. As with the previous three described transects, flow direction was dependent on tidal stage. The outfalls were commonly found flooded with marine water and flow was observed coming from and going into the pipes. Shorebirds were frequently observed along the riprap and on the mudflats directly across the drainage channel from the sampling station.

**Figure 9-5. Sampling site T1A.**

<u>Water Quality</u>

Samples at the base of Outfalls 13 and 14 were collected 73 times on 41 days. Samples at this site were collected during the Chronic Input Investigation Studies, Tidal Influence (24-hour) Studies and High Tide Washing Studies. Multiple samples were collected on a single day during the Tidal Influence (24-hour) and High Tide Washing Studies. Of these samples, 66% had bacterial concentrations that would have exceeded AB411 standards (Table 9-12). Bacterial concentrations ranged from non-detect for all three indicators to 160,000 MPN/100 mL for both total and fecal coliforms and 4,611 MPN/100 mL for *Enterococcus* (Table 9-13).

**Table 9-12. AB411 exceedances summary chart for Outfalls 13 and 14 (T1A).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| T1A | No. of Samples | 73 | 73 | 72 |
| | No. of Samples exceed AB411 criteria | 29 (39.7%) | 37 (50.7%) | 37 (51.4%) |
| | No. of Samples Exceeding Any AB411 criteria | 48 (65.8%) | | |
| | No. of Sample Days | 41 | | |
| | No. of Days Exceeding AB411 criteria | 30 (73.2%) | | |

**Table 9-13. Bacterial indicator results for Outfalls 13 and 14 (T1A).**

| Parameter | Dates Sampled | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total Coliform | April 9 – August 24, 2003 | 814 | <20 – 160,000 |
| Fecal Coliform | April 9 – August 24, 2003 | 360 | <20 – 160,000 |
| *Enterococcus* | April 9 – August 24, 2003 | 113 | <10 – 4,611 |

Six samples were collected for Total Ammonia analyses. Duplicate samples were collected on June 25 and 26, 2003 and July 8, 2003. Total Ammonia was not detected in any of the samples. This suggests that there is not a fresh source of fecal matter being discharged from the Outfalls 13 and 14, therefore, the elevated levels of fecal coliform and *Enterococcus* at this site may be a result of regrowth within the outfall pipe. Concurrent sampling for bacterial indicators showed elevated *Enterococcus* levels (211 MPN/100 mL) on June 26, 2003 and elevated total and fecal coliform levels (1,100 MPN/100 mL each) on July 8, 2003.

Salinity, temperature and pH readings were taken at this sample site. Salinity measurements taken at the base of Outfalls 13 and 14 indicated that freshwater discharge did occur. This was evident by lower salinity values compared to other sites in the estuary. Table 9-14 lists the ranges of values observed for physical water quality parameters.

**Table 9-14. Physical water quality measurements at Outfalls 13 and 14 (T1A).**

| Parameter | Period Sampled | Range |
|---|---|---|
| Salinity | May 29, 2003 – Aug. 24, 2003 | 24ppt – 36ppt |
| Temperature | Jul 24, 2003 – Aug. 23, 2003 | 22.2° C – 25.4° C |
| pH | Jul 24, 2003 – Aug. 23, 2003 | 7.77 – 8.15 |

Potential bacterial sources at this site include a combination of urban runoff being discharged from Outfalls 13 and 14 and regrowth of bacteria inside the tidally influenced portion of the outfall pipes due to an accumulation of organic matter such as kelp and the lack of sunlight.

Station T1A was sampled concurrently as samples collected on Dog Beach during the Tidal Influence (24-hour) Studies and High Tide Washing Studies. These samples were collected to determine if bacterial loading from the Outfalls 13 and 14 was occurring and potentially affecting water quality on Dog Beach.

### *9.1.5 Dog Beach*

Site Description

The sites located on at Dog Beach span the length of Dog Beach. There were 9 permanent sampling locations (DB1 – DB9), however, for most surveys only a few sites (DB1, DB4 and DB6) were surveyed which represented the varied environments at Dog Beach. The western sites DB1 and DB2 (Figure 9-6) were located in the surf zone. Site DB1 is located in the same location as the San Diego County's Department of Environmental Health AB411 sampling site for Dog Beach. The northern sites (DB3, DB4 and DB5; Figure 9-7) were located along a section of beach with a steep face and tidal currents were often swift. The eastern sites (DB6, DB7, DB8 and DB9; Figure 9-8) were located along channels that divided the mudflats. Samples were collected in knee deep water following AB411 guidelines for coastal beaches. Flow direction at each site depended on tidal stage. Shorebirds were more frequent in the eastern portions of the beach and on the mudflats, while dogs were prevalent along the northern and western portions of the beaches. Gulls were frequently observed roosting on the spillway of the River jetty across from the northern portion of Dog Beach. Public usage of Dog Beach is high and varies with time of day, week and year. Activities include surfing, wading, swimming, walking dogs, jogging, sunbathing, and picnicking. Homeless were occasionally observed sleeping on the beach.


**Figure 9-6. Sampling sites DB1 - DB2.**


**Figure 9-7. Sampling sites DB3, DB4, DB5.**


**Figure 9-8. Sampling sites DB6, DB7, DB8. DB9.**

Water Quality

The three Sites DB1, DB4 and DB6 span the length of Dog Beach and represent the different environmental conditions observed. These sites were sampled during the initial investigations performed in Winter 2002-03, the Chronic Input Investigation Studies, Tidal Influence (24-hour) Studies, High Tide Washing Studies and Sand Berm Spreading Studies (DB6 not sampled during the latter). Results for these stations are presented in Appendix B.

Site DB1 was sampled 96 times on 43 days. Multiple samples were collected on a single day during the Tidal Influence (24-hour) Study. Of these samples 10% had bacterial concentrations that would have exceeded AB411 standards (Table 9-15). Bacterial concentrations ranged from non-detect to 11,000 MPN/100 mL for total coliform, 8,000 MPN/100 mL for fecal coliform and 2,400 MPN/100 mL for *Enterococcus*. With the exception of the north station at the Sunset Cliffs Blvd. Bridge (T1D-N), Site DB1 had the lowest geometric means observed throughout the entire River (Table 9-16). The maximum observed concentrations for total and fecal coliforms may be a caused by increased bacterial loads to the shore zone following sand berm spreading operations on April 3 and 4, 2003.

**Table 9-15. AB411 exceedances summary chart for DB1 (DEH's AB411 Site).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| DB1 | No. of Samples | 96 | 96 | 96 |
| | No. of Samples exceed AB411 criteria | 2 (2.1%) | 4 (4.2%) | 8 (8.3%) |
| | No. of Samples Exceeding Any AB411 criteria | 10 (10.4%) | | |
| | No. of Sample Days | 43 | | |
| | No. of Days Exceeding AB411 criteria | 10 (23.3%) | | |

**Table 9-16. Bacterial indicator results for DB1 (DEH's AB411 Site).**

| Parameter | Dates Sampled | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total Coliform | April 9 – August 24, 2003 | 58 | <20 - 11000 |
| Fecal Coliform | April 9 – August 24, 2003 | 50 | <20 - 8000 |
| *Enterococcus* | April 9 – August 24, 2003 | 21 | <10 - 2400 |

Site DB4 was also sampled 96 times on 43 days. Multiple samples were collected on a single day during the Tidal Influence (24-hour) Study. Of these samples 35% had bacterial concentrations that would have exceeded AB411 standards (Table 9-17). Bacterial concentrations ranged from non-detect to 13,000 MPN/100 mL for total and fecal coliform and 4,352 MPN/100 mL for *Enterococcus*. The maximum values did not occur following the storm event of November 28-29, 2002.

**Table 9-17. AB411 exceedances summary chart for DB4.**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| DB4 | No. of Samples | 96 | 96 | 96 |
| | No. of Samples exceed AB411 criteria | 17 (17.7%) | 26 (27.1%) | 23 (24.0%) |
| | No. of Samples Exceeding Any AB411 criteria | 10 (35.4%) | | |
| | No. of Sample Days | 43 | | |
| | No. of Days Exceeding AB411 criteria | 10 (58.1%) | | |

**Table 9-18. Bacterial indicator results for DB4.**

| Parameter | Dates Sampled | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total Coliform | April 9 – August 24, 2003 | 200 | <20 – 13,000 |
| Fecal Coliform | April 9 – August 24, 2003 | 161 | <20 – 13,000 |
| *Enterococcus* | April 9 – August 24, 2003 | 43 | <10 – 4,352 |

Site DB6 was sampled 80 times on 37 days. Multiple samples were collected on a single day during the Tidal Influence (24-hour) Study. Of these samples 28% had bacterial concentrations that would have exceeded AB411 standards (Table 9-19). Bacterial concentrations ranged from non-detect to 5,000 MPN/100 mL for total coliform, 3,000 MPN/100 mL for fecal coliform and 723 MPN/100 mL for *Enterococcus* (Table 9-20). The maximum total coliform concentration followed the storm event on November 28-29, 2003.

**Table 9-19. AB411 exceedances summary chart for DB6.**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| DB6 | No. of Samples | 80 | 80 | 80 |
| | No. of Samples exceed AB411 criteria | 9 (11.3%) | 13 (16.3%) | 18 (22.5%) |
| | No. of Samples Exceeding Any AB411 criteria | 22 (27.5%) | | |
| | No. of Sample Days | 37 | | |
| | No. of Days Exceeding AB411 criteria | 15 (40.5%) | | |

**Table 9-20. Bacterial indicator results for DB6.**

| Parameter | Dates Sampled | Geometric Mean (MPN/100 mL) | Range (MPN/100 mL) |
|---|---|---|---|
| Total Coliform | April 9 – August 24, 2003 | 165 | <20 – 5,000 |
| Fecal Coliform | April 9 – August 24, 2003 | 135 | <20 – 3,000 |
| *Enterococcus* | April 9 – August 24, 2003 | 40 | <10 - 723 |

Potential sources of bacteria at Sites DB1, DB4 and DB6 include dog and bird feces (including those found on the wrack line), influence from the River, and discharge from Outfalls 13 and 14. Bacterial contamination from bird feces can be from direct contribution on the shoreline, specifically in at Sites DB4 and DB6, transport through the water from across the channel as surf washes the spillway in the River jetty and transport through the water from the mudflats east of Dog Beach.

<u>Tidal Influence (24-hour) Studies</u>

The majority of samples collected at Sites DB1, DB4 and DB6 were during the Tidal Influence (24-hour) Studies. These surveys were conducted to determine if there was a specific tidal period that contributed to increased bacterial concentrations in the water column. As documented by Boehm (2003), studies showed that samples collected during spring tides and/or during night hours (lack of sunlight) had higher bacterial concentrations.

Four surveys were conducted, two during spring tides and two during neap tides. Days were selected that had similar tidal heights (neap tides had smaller tidal ranges), with the low and high tides occurring at approximately the same time during the day. Samples were simultaneously collected at Sunset Cliffs Blvd. Bridge (T1D) and Outfalls 13 and 14 (T1A) to determine if there was an upstream source that may potentially contribute elevated bacteria levels, influencing the survey results. Samples were collected every 2 hours on Dog Beach and every 4 hours at Sunset Cliffs Blvd. Bridge (T1D). The Outfalls 13 and 14 were not sampled during the first effort (April 23-24), sampled every 12 hours during the second effort (May 8-9), sampled every 6 hours during the third effort (June 11-12) and sampled every 4 hours during the fourth effort (June 25-26).

Figures 9-9 through 9-12 illustrate the results for the *Enterococcus* indicator organism, for samples collected during all four 24-hour surveys. The graphs show the change in concentration for three stations on Dog Beach, a straight average of three samples collected across the upstream river transect at Sunset Cliffs Blvd. Bridge and tide height. The shading corresponds to periods of the study with UV light absent.

The surveys conducted during neap tides are shown in Figures 9-9 and 9-10. The data show levels for *Enterococcus* to be variable and no discernable correlation to tide height. This may be a function of the small tidal range during neap tides and preceding spring tides may have pushed wrack line material beyond the washing effects of the neap high-high tide. Previous studies by Boehm (2002) showed bacterial levels during neap tides to be low. For samples collected on April 23 – 24, 2003, there does appear to be lower values during day hours and high UV levels. This trend was not evident on May 8 – 9, 2003. However, elevated bacterial levels were observed at the base of Outfalls 13 and 14 suggesting discharge from these pipes may be influencing water quality at Dog Beach. The upstream station, T1D, had lower *Enterococcus* concentrations than stations on Dog Beach, particularly on May 8 – 9, 2003, suggesting transport of bacteria downstream was not occurring.

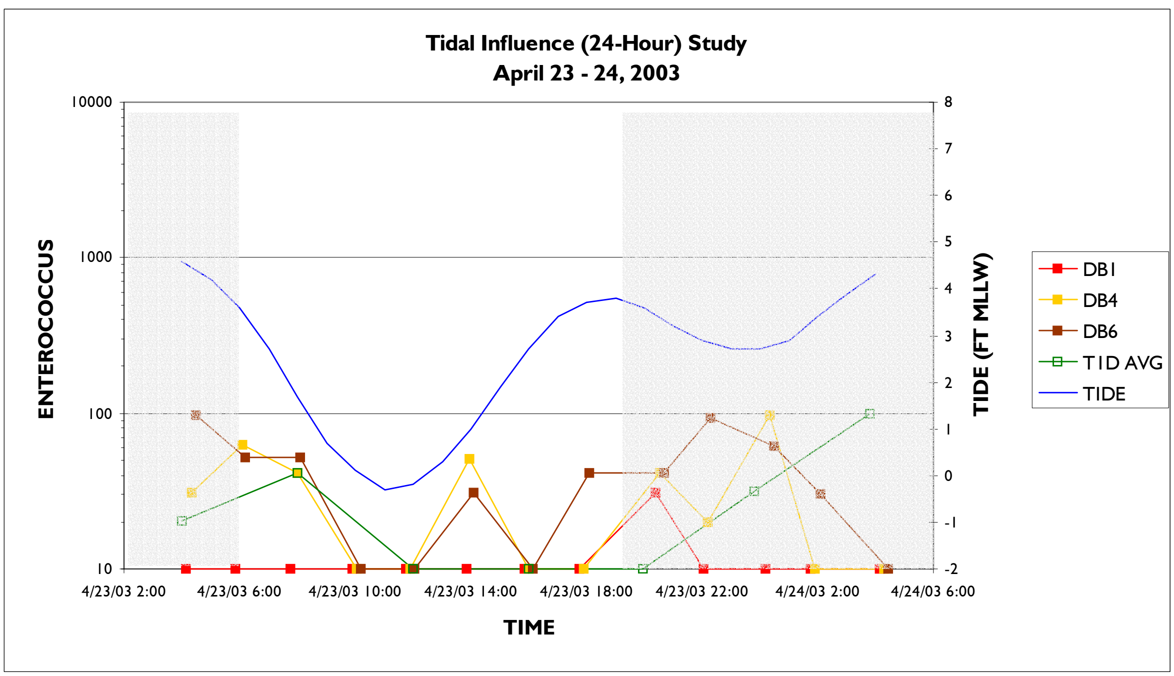



**Figure 9-9. Tidal influence (24-hour) study for *Enterococcus* indicator, April 23-24, 2003.**

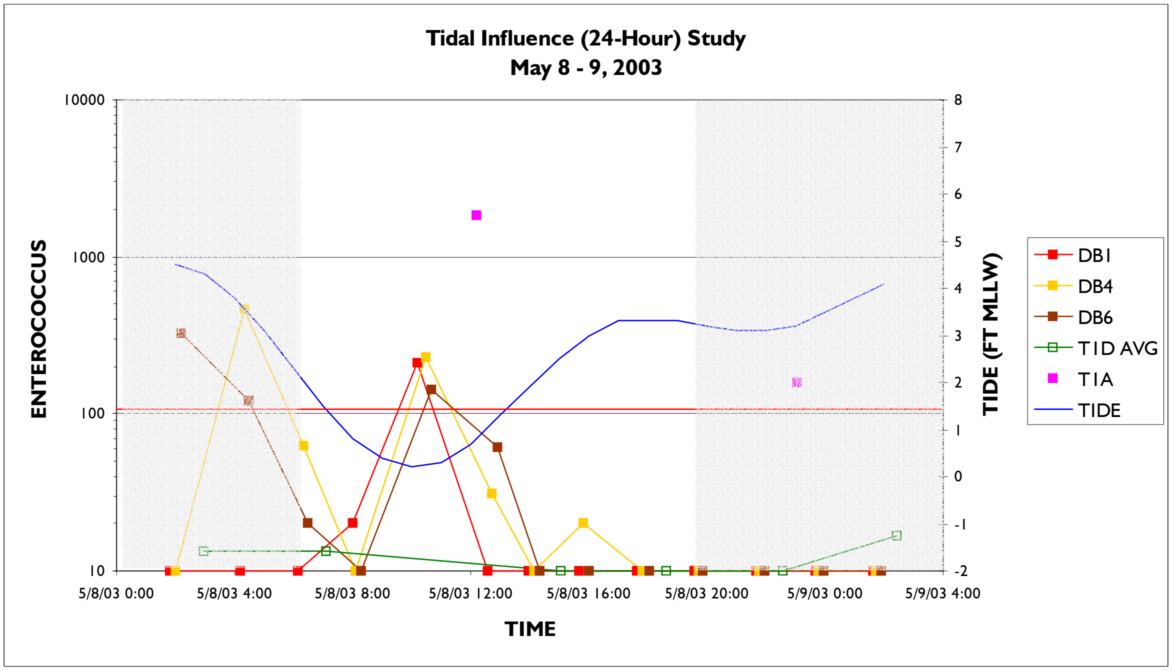



**Figure 9-10. Tidal influence (24-hour) study for *Enterococcus* indicator, May 8-9, 2003.**

The surveys conducted during spring tides are shown in Figures 9-11 and 9-12. The direct relationship to tidal heights was more readily apparent in these graphs. These data confirmed trends as seen in studies performed by Boehm (2002) that showed higher bacterial concentrations occurring during periods of springs tides. The bacterial indicator *Enterococcus* increased 1 to 2 orders of magnitude in conjunction with the extreme high tide occurring in the evening hours. With the absence of UV light during the night, concentrations of *Enterococcus* declined slowly, likely due to the bactericidal effects of salt water. With the increase of UV levels during day hours, the *Enterococcus* concentrations were nearly always undetectable. The upstream station, T1D, followed a similar trend, though bacterial concentrations were lower during the night hours than stations on Dog Beach. This suggests that the incoming tide may be affecting this station rather than a source from upstream that was unaffected by tidal conditions. During the spring tide surveys, samples collected at the base of Outfalls 13 and 14 often had higher levels of bacteria during lower tide levels, suggesting that the tidal washing of the Outfalls 13 and 14 was flushing bacteria from these pipes. A complete graphical representation of these studies can be found in Appendix B.

Due to the presence of several confounding variables such as discharge from Outfalls 13 and 14, presence or absence of wrack line material and the presence or absence of UV light, the ANOVA analyses performed were insufficient to discern relationships of bacterial concentrations to tide heights.

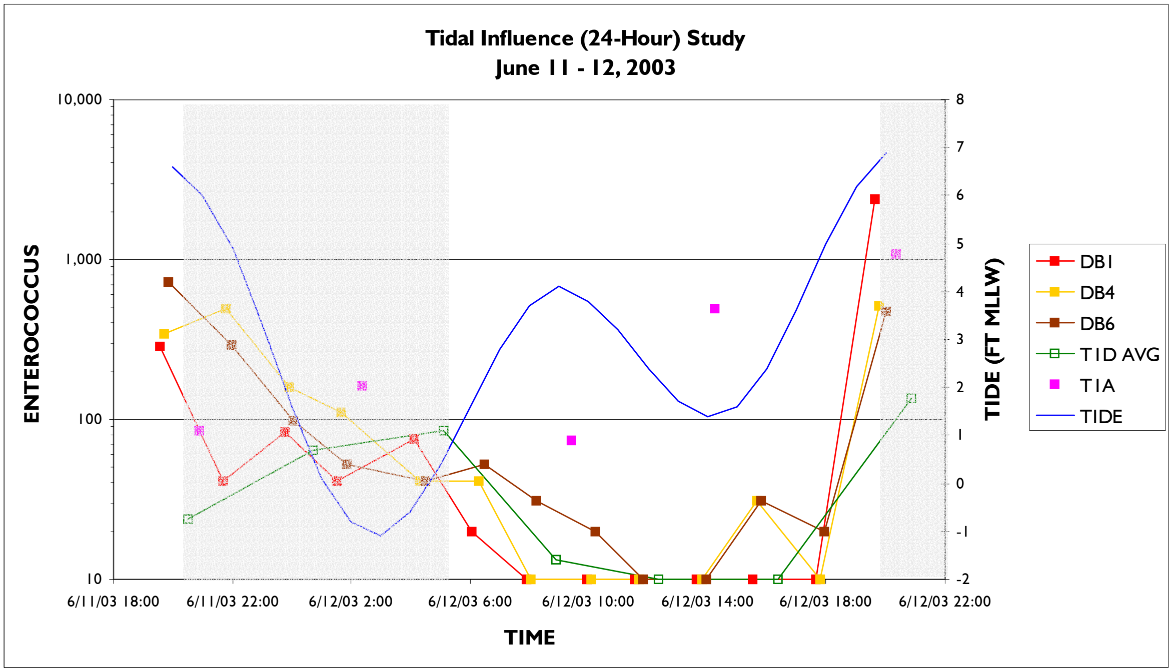



**Figure 9-11. Tidal influence (24-hour) study for *Enterococcus* indicator, June 11-12, 2003.**

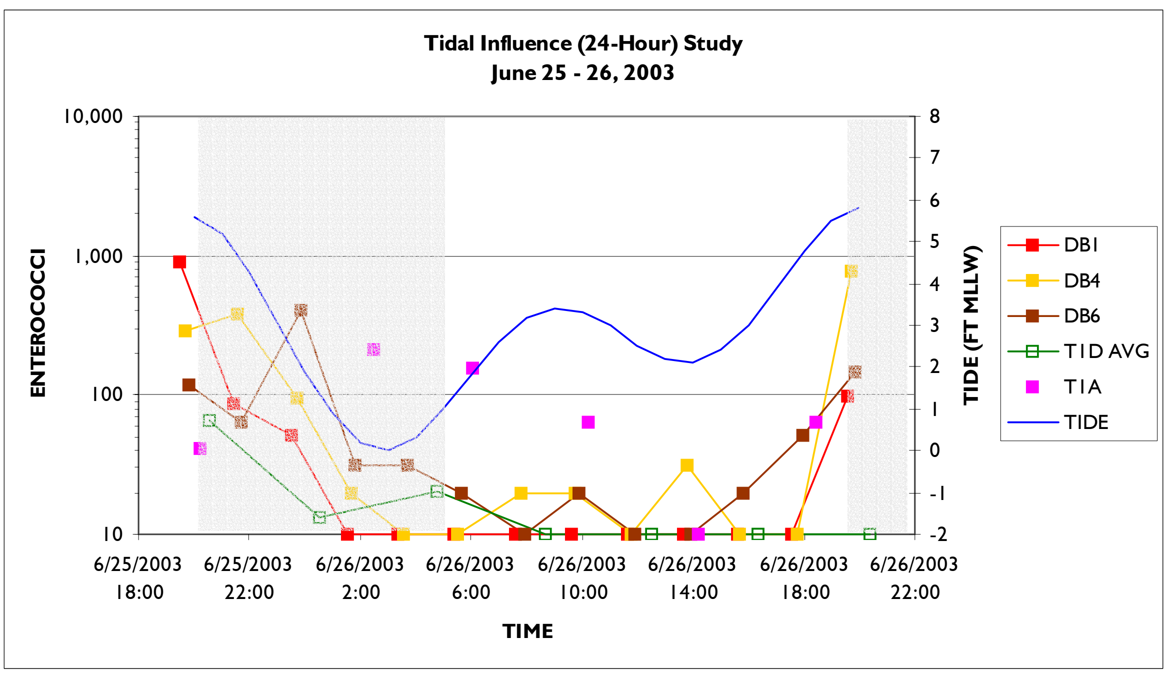
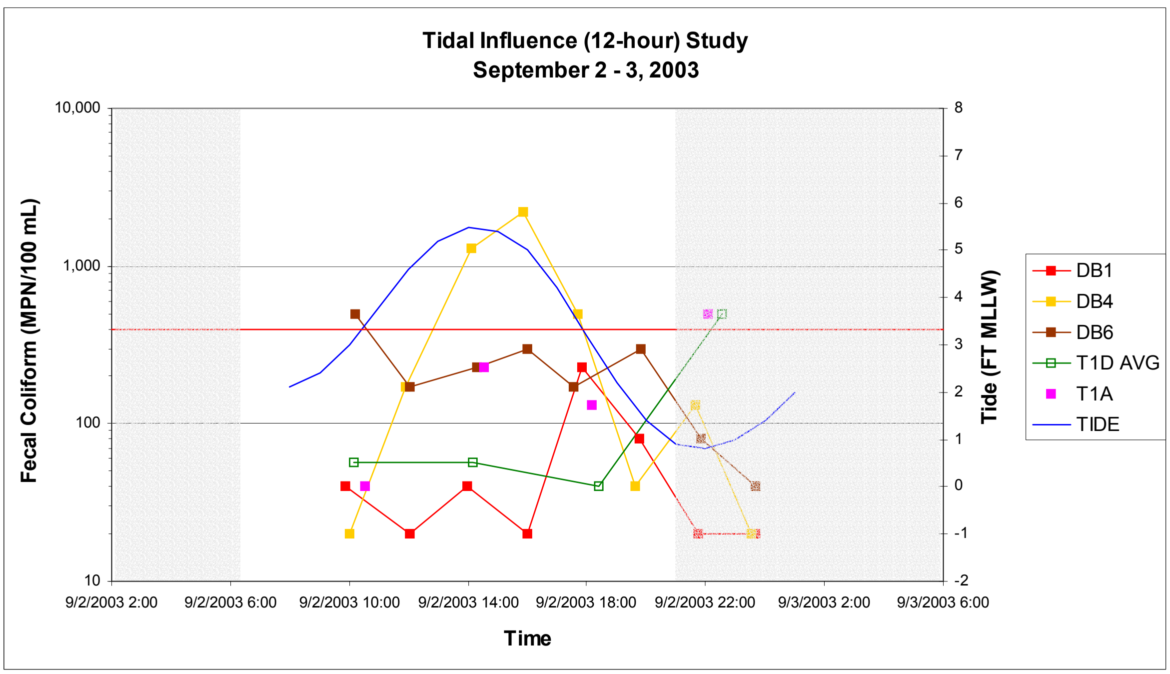



**Figure 9-12. Tidal influence (24-hour) study for *Enterococcus* indicator, June 25-26, 2003.**

On September 2, 2003, a similar study was performed to the Tidal Influence (12-hour) Studies (Figure 9-13). This study was performed on a spring tide when the extreme high tide was during mid day, rather than in late evening hours as previously conducted, and the extreme low tide was during the late evening hours. This study effort was performed to confirm that the apparent increase in bacterial concentrations was related to tide heights rather than the absence of sunlight. Samples were collected in the same manner as the original studies; however, this study was performed over a fourteen hour period, collecting samples a few hours before the extreme high through a few hours following the extreme low.




**9-13. Tidal influence (12-hour) study for *Enterococcus* indicator, September 2-3, 2003.**

Although one sampling event is not enough to perform statistical analyses, trends in the results confirmed assumptions. At low tide, the bacterial indicator levels did not spike with the decrease of UV light in the evening hours, suggesting that tides were a greater factor in the increase of bacterial levels rather than the absence of sunlight. Increases in the bacterial concentrations were observed at the high tide during the afternoon hours.

High Tide Washing Studies

The results from the Tidal Influence (24-hour) Studies suggested that elevated bacterial concentrations were directly related to tide height. A focused study at determining the bacterial source or transport mechanism around the peak high tides was developed. The study was initially designed to sample only once during the day, following the high tide, and focused around public usage patterns. Samples were collected on three days around Memorial Day, May 22 – 28, 2003 utilizing this initial design. The initial sampling design was found lacking some key elements and the final High Tide Washing Studies sampling design was created. The study aimed at resolving any potential differences between areas on the beach containing higher concentrations of dog feces to areas absent of dog feces. The study was also designed to differentiate between regions of the beach, west, north and east.

The survey began with observations of the wrack line to determine locations of dog feces. Sample locations were adapted to sample areas of high and low dog feces concentrations in each of the three regions (i.e. Sample ID WAH refers to **W**est **A**rea, **H**igh dog feces concentrations). The eastern region only had one sample location representing low dog feces concentrations; high dog feces concentrations in this area were not observed. Samples were collected approximately 3 hours prior to high tide, during the high tide and 3 hours following the high tide. During the high tide sampling, the wrack line was being washed. Triplicate samples were collected at each station. Samples at Sunset Cliffs Blvd. Bridge and at the base of Outfalls 13 and 14 were concurrently sampled to determine if any potential upstream sources were present. Site OB4 was also sampled to determine if the same effect is noticed on Ocean Beach and whether sources south of Dog Beach were contributing to bacterial concentrations at Dog Beach.

On Dog Beach, *Enterococcus* concentrations in water collected during the peak high tide were significantly greater (alpha = 0.05) than samples collected prior to high tide. Samples collected following the high tide tended to have higher log means than those collected prior to the high tide. The samples collected following the high tide were collected at night, without the bactericidal effects of sunlight. This may be the reason for the bacterial concentrations to remain elevated following the high tide washing of the wrack line.

The analyses also showed that there was no significant difference (alpha = 0.05) between regions on the beach for all three bacterial indicators except for samples collected in the western region, high dog feces area. Total and fecal coliforms were significantly lower at this site than other Dog Beach sites. This may be due to the bactericidal effects saltwater has on these bacterial indicators and the ability for *Enterococcus* to withstand higher saltwater concentrations.

Figures 9-14 through 9-17 illustrate the results for the *Enterococcus* indicator bacteria for samples collected during all four high tide washing surveys. The graphs show the change in bacterial concentrations in relation to the change in tide height. In each graph, the blue shaded area represents samples collected approximately 3-hours prior to high tide (and typically prior to washing of the wrack line). The non-shaded area represents samples collected during the high tide when maximum washing of the wrack line was occurring. The green shaded area represents samples collected approximately 3-hours following the peak high tide.

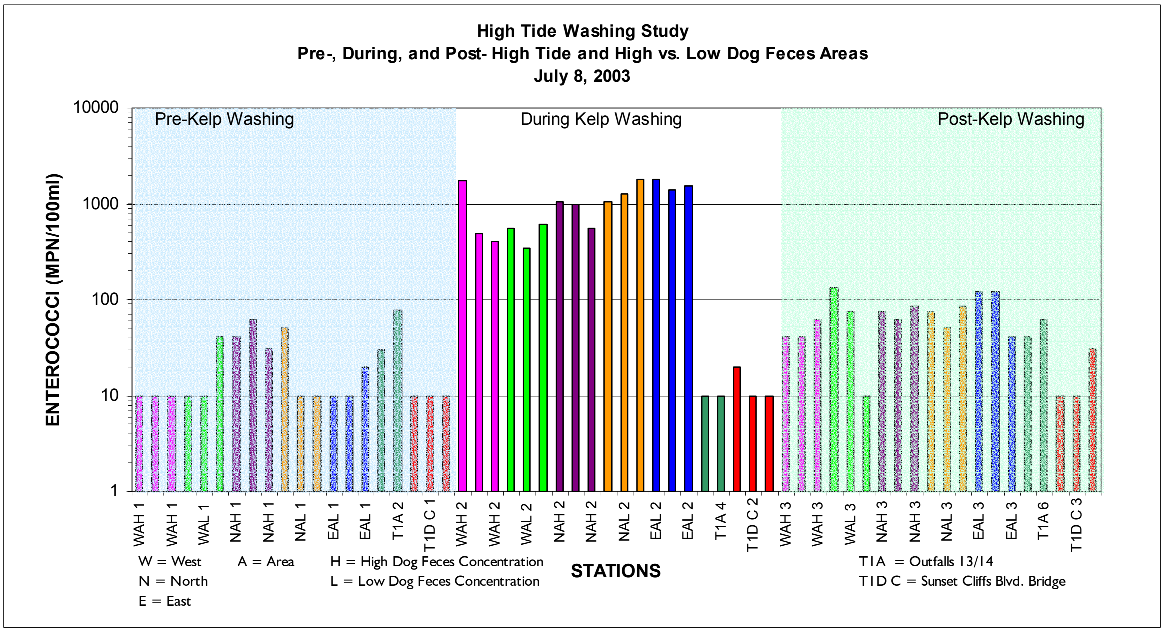



**Figure 9-14. Tidal influence (24-hour) study for *Enterococcus* indicator, July 8, 2003.**

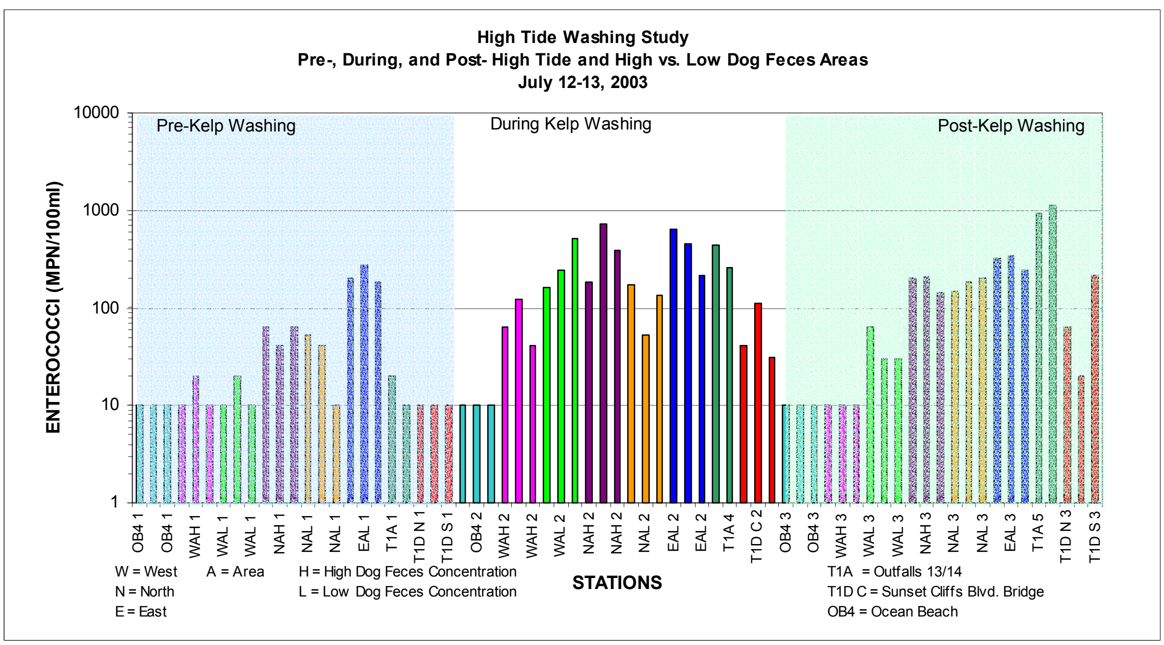



**Figure 9-15. Tidal influence (24-hour) study for *Enterococcus* indicator, July 12-13, 2003.**

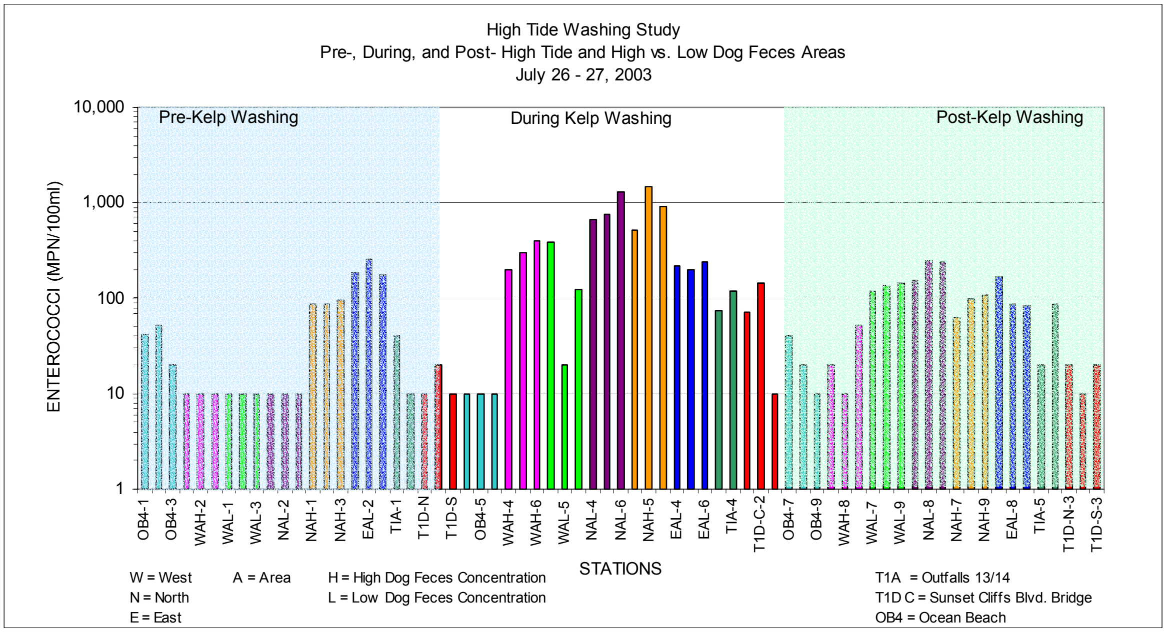



**Figure 9-16. Tidal influence (24-hour) study for *Enterococcus* indicator, July 26-27, 2003.**

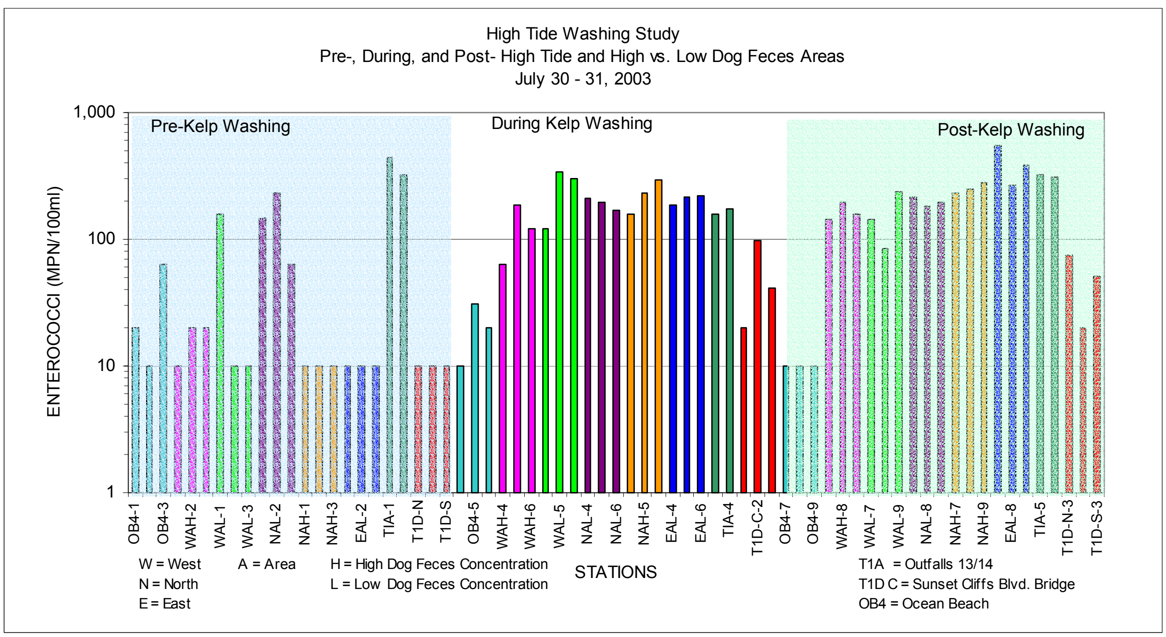



**Figure 9-17. Tidal influence (24-hour) study for *Enterococcus* indicator, July 30-31, 2003.**

Statistical analyses (Table 9-21) showed the following results. No significant difference (alpha = 0.05) was found between areas with apparently greater concentrations of dog feces versus areas with no apparent dog feces. This suggests that bacterial contamination is not solely coming directly from dog feces. Regrowth of bacteria on the wrack line with an unknown mechanism of transport (flies or tidal washing) is the likely cause of elevated bacterial concentrations in areas without apparent dog feces.

**Table 9-21. Comparison of log means for SDR Mouth sites, and significant differences.**

| Parameter | Region or Site | Dog Feces | Log Mean | Tukey Grouping* |
|---|---|---|---|---|
| Total Coliform | East | Low or None | 2.6521 | AB |
| | North | High | 2.6671 | A |
| | | Low or None | 2.5941 | ABC |
| | West | Low or None | 2.2389 | BC |
| | | High | 2.2052 | C |
| | TID | NA | 1.7783 | D |
| | Ocean Beach (OB4) | NA | 1.4973 | D |
| Fecal Coliform | East | Low or None | 2.6104 | A |
| | North | High | 2.6288 | A |
| | | Low or None | 2.5499 | AB |
| | West | Low or None | 2.2210 | AB |
| | | High | 2.1733 | B |
| | TID | NA | 1.7367 | C |
| | Ocean Beach (OB4) | NA | 1.4527 | C |
| *Enterococcus* | East | Low or None | 2.1838 | A |
| | North | High | 2.0601 | A |
| | | Low or None | 2.1429 | A |
| | West | Low or None | 1.8099 | AB |
| | | High | 1.6437 | BC |
| | TID | NA | 1.3363 | CD |
| | Ocean Beach (OB4) | NA | 1.1644 | D |

* Means with the same letter are **NOT** significantly different.

Samples collected at Ocean Beach (OB4) and Sunset Cliffs Blvd. Bridge (TID) were shown to have significantly lower bacterial concentrations than those sites on Dog Beach. This indicated that there were no potential sources coming from upstream in the River or from the marine environment to influence the High Tide Washing Survey. There were no significant differences (alpha = 0.05) in samples collected prior to, during, and following high tide washing at Ocean Beach (OB4).

Samples collected at Outfalls 13 and 14 (T1A) were not included in the analyses due to inadequate sample size, however, it should be noted that samples collected at this site frequently had the highest bacterial concentrations. Due to the upstream direction of flooding tides during the pre- and during high tide surveys, the influence of potential discharge from Outfalls 13 and 14 on Dog Beach were expected to be minimal. Flow was frequently observed to be going into the pipe at the time of sampling during the pre-high tide sampling events. It was not determined if these elevated bacterial levels were a result of discharge from the Outfalls or if the beach sites may have been influencing this site.

#### 9.1.5.1 Miscellaneous Dog Beach Sites

The remaining Dog Beach sites, DB2, DB3, DB5, DB7, DB8 and DB9 were seldom sampled. With the exception of DB2, each were sampled 4 times, once during the initial investigations conducted on January 27, 2003 and three times during initial project design of the High Tide Washing Studies. Site DB2 was sampled an additional 13 samples over 5 days during the Sand Berm Spreading Studies and discussed in Section 10. The samples collected at these sites had bacterial concentrations similar to or less than Sites DB1, DB4 and DB6. Results for these stations can be found in Appendix B.

#### 9.1.5.2 Sediment Samples

Sediment samples were collected on January 29, 2003 to determine bacterial levels in surface sediment (sand or river mud). Samples were collected at six sites on the exposed mudflats east of Dog Beach, six sites on the eastern region of Dog Beach and one reference site on Ocean Beach (Figure 9-17). Table 9-22 lists the bacterial analysis results for these samples. The results indicated that neither the sediment found on the mudflats or along Dog Beach (eastern region) appear to be a significant source of bacterial contamination to the water quality in the River.


**Figure 9-17. Sediment sampling station locations.**

**Table 9-22. Bacterial indicator results for sediment samples on Dog Beach.**

| Site/Sample ID | Total Coliform (MPN/gram dry weight) | Fecal Coliform (MPN/gram dry weight) | *Enterococcus* (MPN/gram dry weight) |
|---|---|---|---|
| DBS-6 | <10 | <10 | 2 |
| DBS-7 | 38 | 38 | 67 |
| DBS-8 | 100 | 100 | 42 |
| DBS-9 | 34 | 34 | 5 |
| DBS-10 | 16 | 16 | 5 |
| DBS-11 | <10 | <10 | 5 |
| OB Reference | <10 | <10 | <1 |
| MF-1 | 36 | 36 | 226 |
| MF-2 | 17 | 17 | 14 |
| MF-3 | <10 | <10 | 23 |
| MF-4 | 18 | 18 | 15 |
| MF-5 | <10 | <10 | 23 |
| MF-6 | 8 | 8 | 41 |

### *9.1.5.3 Kelp Sampling Surveys*

Results from the Tidal Influence (24-hour) Studies and High Tide Washing Studies indicated that higher bacterial concentrations were observed during and following periods of high tides. The increase in bacterial concentrations tended to spike in relation to the peak of the high tide and declined slowly with decreasing tide heights. Observations suggested that the washing of the wrack line may be a mechanism to transport bacteria surviving on the decomposing marine vegetation or fecal matter into the water column.

Although Dog Beach regulations state that owners must pick up after their pets, dog feces were still observed on the beach, specifically in the wrack line. These wastes were likely the primary source of bacterial inoculation of the wrack line (kelp) if not the primary source of loading in this environment. Fecal matter from birds was also a potential source.

Initial investigations conducted on December 1, 2002 and January 26, 2003 confirmed the presence of dog fecal matter on the beach. Survey lines across the beach were set and observations of dog feces along the lines made. Observations of dog feces were low along survey lines; however, additional observations indicated that dog feces were relatively more abundant within the wrack line. Figure 9-18 is an example of typical survey results. Subsequent survey methods were altered to note the presence of dog feces solely within wrack line. Surveys conducted throughout Spring and Summer 2003 continued to note the presence of dog feces. Dog feces counts were believed to be underdocumented due to camouflage with the wrack line and burial.

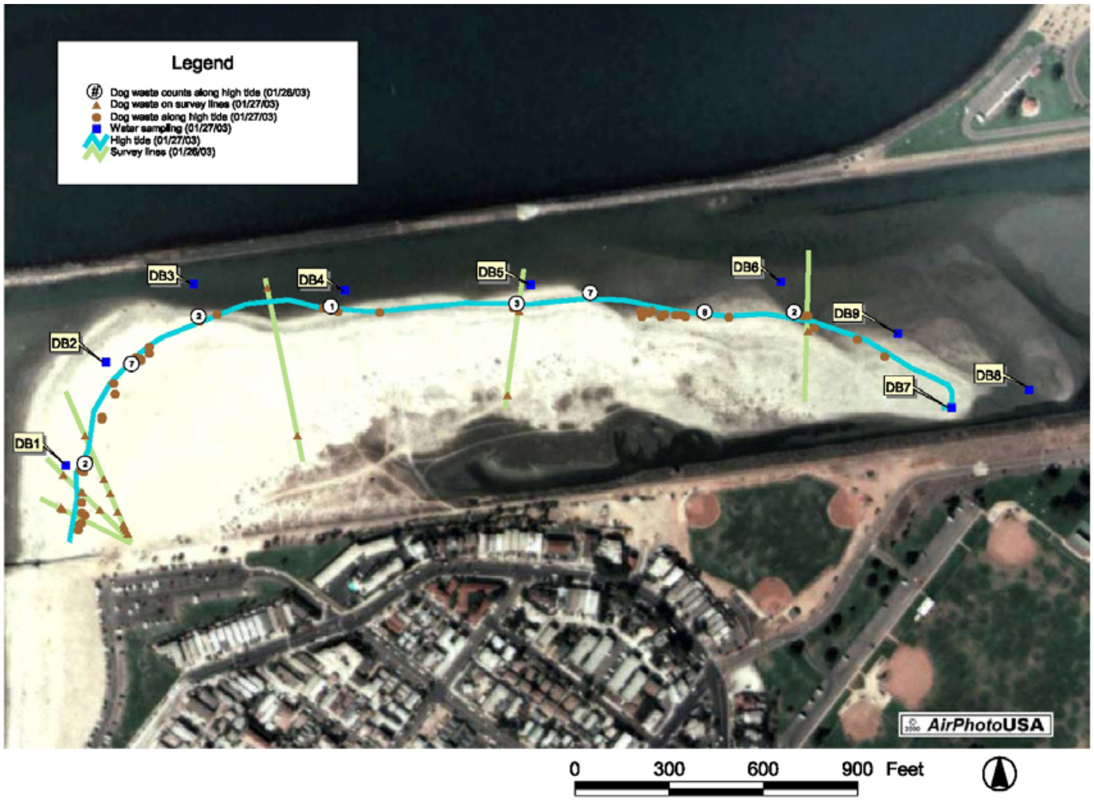



**Figure 9-18. Dog feces survey results, January 26-27, 2003.**

**Figure 9-19. Kelp sampling on Dog Beach.**

The presence of dog feces within the wrack line and published literature suggesting the potential for regrowth of bacterial indicators in the decomposing vegetation prompted samples of the wrack line to be collected. Samples were collected on August 12 and 27, 2003 (Figure 9-19). Samples consisted of freshly deposited kelp and eelgrass as well as kelp and eelgrass in various decomposing stages. Samples were also collected with or without the apparent presence of dog waste in the vegetation pile. Fresh and decomposing kelp and eelgrass reference samples were collected from Ocean Beach near the Ocean Beach Pier, removed from the potential influence of bacteria from dog fecal matter. Sample collection methods and the analytical lab procedures are documented in Appendix C.

The first round of samples were analyzed with only one set of dilutions in the lab, therefore the results could only indicate the concentration up to a certain maximum number. Results for total and fecal coliforms indicated bacterial concentrations greater than 15,000 MPN/gram of vegetation on decomposing vegetation with or without apparent dog feces present. *Enterococcus* results for the same samples typically were greater than 2,400 MPN/gram of vegetation. Freshly deposited vegetation samples collected at Dog Beach had a maximum total and fecal coliform concentration of 2,161 MPN/gram of vegetation. Freshly deposited vegetation samples from the Ocean Beach reference site were non-detect while decomposing vegetation collected at the reference site, without the apparent presence of fecal matter, had total coliform concentrations that ranged from 106 to 769 MPN/gram of vegetation, fecal coliform concentrations that ranged from 29 to 674 MPN/gram of vegetation and *Enterococcus* concentrations that ranged from 280 to >2,327 MPN/gram of vegetation. Complete results are listed in Appendix B along with observations on the condition of the samples.

Samples collected on August 27 were analyzed with greater dilutions, providing a more accurate bacterial concentration range. The data for all three bacterial indicators are shown in Figures 9-20 through 9-22. All seven of the freshly deposited vegetation samples, including those from the Ocean Beach reference site had non-detect or results of 1 MPN/gram of vegetation for all three bacterial indicators except two. Two fresh samples from Dog Beach had elevated levels of total coliforms, one listed at 33,256 MPN/gram of vegetation and the other listed at 5,081 MPN/gram of vegetation. Fecal coliforms were detected on these two samples, however, concentrations were low (21 MPN/gram of vegetation and 7 MPN/gram of vegetation, respectively). The decomposing vegetation collected from Dog Beach, with or without the presence of dog feces, ranged from 41 to 144,527 MPN/gram of vegetation for total and fecal coliforms and from 13 to 40,268 MPN/gram of vegetation for *Enterococcus*. The Ocean Beach reference site samples that were decomposing with no apparent dog fecal matter present also had elevated levels of bacterial indicators present, with total coliforms that ranged from 1,329 to 9,255 MPN/gram of vegetation, fecal coliforms that ranged from 356 to 1,329 MPN/gram of vegetation and *Enterococcus* that ranged from 18 to 76 MPN/gram of vegetation.

These results show that decomposing vegetation comprising the wrack line, with or without the apparent presence of fecal matter, may have elevated bacterial indicator concentrations, that, when subjected to washing at high tide levels, may contribute to water quality impacts. The mechanisms that potentially transport bacteria from one wrack pile to another and the time needed for elevated bacterial indicator levels to appear on vegetation after being deposited was not studied. Therefore, it is not known whether the presence of freshly deposited dog or bird feces on the vegetation is necessary to observe elevated bacterial concentrations or whether ambient environmental conditions exist that promote the growth and regrowth of bacterial indicator organisms on decomposing marine vegetation.

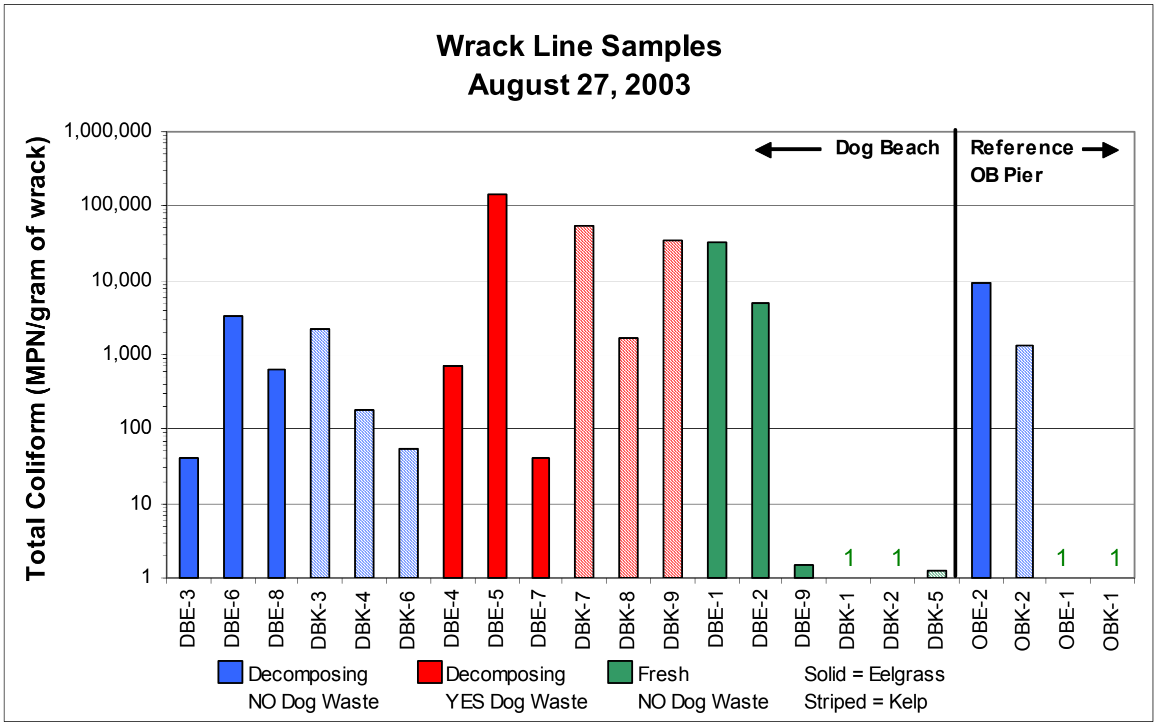



**Figure 9-20. Wrack Total Coliform Results**

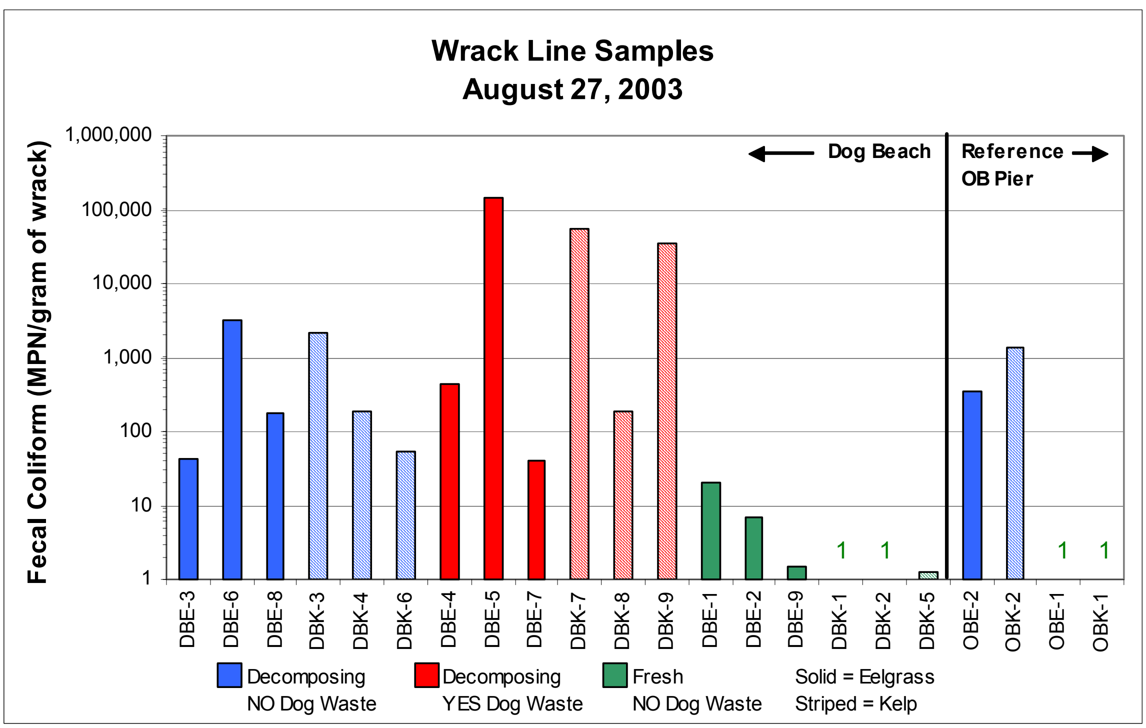



**Figure 9-21. Wrack Fecal Coliform Results**

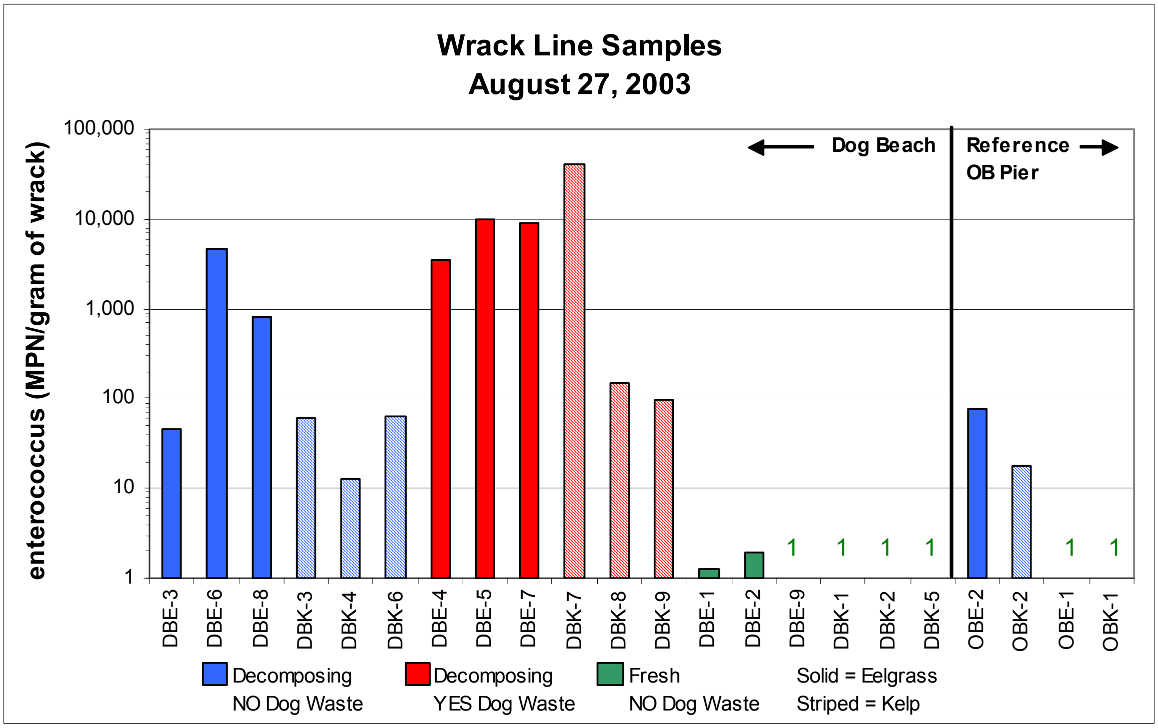



**Figure 9-22. Wrack *Enterococcus* Results**

## *9.2 Storm Drain Infrastructure/Diversion System*

### *9.2.1 Outfalls 13 and 14 (Transect T1A)*

The two westernmost outfalls on the River are designated numbers 13 and 14 in the Hirsch & Company report and have diversion systems in place. The two outfalls are located approximately 1,000 feet east of Dog Beach. The drainage area for these two outfalls is the northwest area of Ocean Beach, but each serves a distinct section. It is important to note that the current number designation of the outfalls is reversed from the original labeling in the Hirsch and Co. report. The designations used in this report are as found in the field and in current use by the City of San Diego.

Outfall 13 is the outlet for a 48" RCP storm drain located in an alley just west of Bacon Street that serves the west side of Ocean Beach along Abbott Street. It is diverted by actuating a valve (V-13 or DV-13) located just west of the diversion box. The diversion box is 15 feet east of the northeast corner of sewer pump station (SPS) 10. The storm drain flow travels west to an 18" sanitary sewer line located just east of SPS 10. The diverted water enters the sewer line at a sewer manhole located 10 feet east of SPS 10.

Outfall 14 is the outlet for a 60" reinforced concrete pipe (RCP) storm drain located on Bacon Street and serves the eastern part of Ocean Beach bordered by Bacon Street on the west and

Newport on the South (approximately 2/3 of runoff and storm water from Ocean Beach goes to the River through this collection system). Outfall 14 is also diverted by a valve (V-14 or DV-14) located on the west side of the diversion box. The diversion box is on the northwest corner of the intersection of Bacon Street, Park Road, and West Point Loma Boulevard. Flow is directed from the storm drain by gravity going west to an 18" sewer main located on West Point Loma Blvd. The flow enters the sewer at a manhole located on West Point Loma Blvd at the entrance of SPS 10.

Both outfalls 13 and 14 are equipped with Tideflex valves as shown in the photo (Figure 9-23). On numerous occasions they were inspected and found to be partially open (especially at high tide).

**Figure 9-23. T1A – Outfalls 13 and 14.**

Investigations were conducted to identify potential sources of high bacteria measured at the location of these two outfalls. This section of the storm drain system was inspected using closed circuit television by Affordable Pipeline Services (San Diego, CA) on July 16, 2003. The inspection was conducted in the early morning hours during a low tide of approximately -0.9 feet to minimize the amount of water in the pipeline.

Outfall 14 has an estimated length of 700 feet from the point of entry at Bacon Street to the outlet located on the south bank on San Diego River. The water level upon entry was estimated at 8 inches. The inspection was conducted moving downstream towards the outlet. The pipeline was observed to have sediment starting at 74.3 feet and increasing in depth from 4 inches at 136.2 feet to 6 inches at 424.0 feet. The sediment interfered with the inspection when the sediment level blocked movement of the remotely operated camera system. Throughout the survey debris, kelp, fish and sediment were observed in the pipeline. The pipeline was also observed to be in good structural condition. No breaks, tree-root intrusions or joint separations were observed. Two lateral connections were documented at 250 and 341.9 feet and observed to be dry.

Outfall 13 was inspected starting at the manhole in the alley next to sewer pump station 10. The length of the pipeline is estimated to be 300 feet from the point of entry to the outlet in the River. The water level at entry in the manhole was 10 inches and sediment was found at 40.7 feet at a depth of 6 inches. The inspection was halted when an intruding lateral was found at 9 o'clock that blocked the camera. The intruding lateral blocked approximately 50% of the storm drain cross-sectional area.

### 9.2.2 Transects T1B and T1C (Robb Field Parking Lot, West and East)

The next two outfalls moving upstream in the River do not have diversions and are the outlets for the parking lots at Robb Field. These outfalls labeled 11 (Site T1C) and 12 (Site T1B) were selected for elimination from diversion in 1987. They are described as drainage on Park Road with 12 and 18 inch diameter outlets, respectively (Hirsch & Co. 1987). At the time this evaluation was conducted, these two outfalls do not appear to contribute urban runoff during dry periods and would not benefit from diversion.

### 9.2.3 Outfall 10

Outfall 10 (three 60" reinforced concrete pipes (RCP)) located just east of Sunset Cliffs Blvd Bridge discharges a 72" storm drain just east of Nimitz Blvd. This storm drain has a diversion box located 330 feet east of Nimitz Blvd. and 340 feet north of W. Point Loma Blvd (southwest corner of W. Point Loma and Nimitz Blvds). The diversion valve (V10 or DV10) is located on the west side of the diversion box. When the valve is in the open position it is set to divert the water in the storm drain to the sanitary sewer system. During dry weather periods this allows urban runoff to gravity flow in a northwest direction to a 24" sewer main located north of West Point Loma Blvd. The storm drain pipe ends at a sewer manhole 220 feet northwest of the diversion box.

The runoff area for this storm drain is the highly urbanized area of eastern Ocean Beach and portions of Point Loma. This 72" storm drain line runs perpendicular to the 36-inch Ocean Beach Trunk Sewer Line.

This outfall was inspected on April 10, 2003. There was no flow observed coming from the outfall, therefore no samples were collected for analysis. No further investigations were performed at this site.

### 9.2.4 Outfall 9 – Famosa Slough

This outfall consists of three 60-inch RCP outlets with manual slide gates located on the south jetty of the River at the mouth of Famosa Slough/Creek (Figure 9-24). The discharge to the River is from the slough and the residential area surrounding the slough.

**Figure 9-24. Famosa Slough Outfalls.**

The slough receives dry and wet weather flows from several residential neighborhoods either through storm drain outfalls or sheet flow from the surrounding streets. A survey of Famosa Slough conducted on June 19, 2003, did not reveal any persistent and significant sources of bacteria (sewer line cross-connections, illegal discharges, etc.) to San Diego River. During the site visit the perimeter of the slough was surveyed with the assistance of a member of the Friends of Famosa Slough organization. During the survey, visual field observations were conducted that identified minor and transient sources of bacteria, such as: human feces from homeless (rare), and dog feces from residents using the slough trails for exercise. Background levels of bacteria may be contributed, on a seasonal basis, by birds that use the slough. This is expected to be higher during the winter migration to Southern California.

Two significant infrastructure features and BMPs exists at the slough: urban runoff and storm water treatment ponds are located on the southern end (corner of Valeta and Worden Streets); and a diversion system for runoff from West Point Loma Blvd. by an Interceptor Pump Station IPS 11 (or I-11 in the Hirsch & Co. report) located on the north side of Famosa St. at West Point Loma Blvd. These storm drain lines have Tideflex outfall valves installed. The diverted runoff is pumped east to an existing 36" sewer main located in West Point Loma Blvd at a manhole located 175 feet east of the pumping station.

On April 10, 2003, flow was observed being discharged into the River from these outfalls. One sample was collected. None of the bacterial indicators were present at levels above the detections limits. No further sampling was performed at this station.

A site reconnaissance of Famosa Slough, upstream of Outfall 9, was performed on June 19, 2003. There were no observations made of runoff into the slough at the time, however, an interview with a member of Friends of Famosa Slough indicated overland flow into the slough has been documented on several occasions, specifically during rain events or water main breaks.

### *9.2.5 Outfall 8*

The outfall is located just west of the Sports Arena Bridge on the south bank of the River. This 60 inch RCP outfall is equipped with a flap gate. The drainage includes the area southwest of Midway including Larga Circle and Kemper Street. It also includes drainage from a small area on Ollie Street. The diversion to the Ocean Beach Trunk Sewer was proposed in 1987 by Hirsch & Co. but not installed.

This site was investigated on April 10, 2003. The water level covered the base of the outfall (tide level +0.7 feet) therefore no determination could be made if effluent was being discharged. No samples were collected and no further investigations were conducted.

### *9.2.6 Sanitary Sewer System Force Mains*

Two large force mains transport municipal sewage from Mission Bay to the Pt. Loma Lateral Main in Ocean Beach. These force mains are buried under the River and Dog Beach below the areas surrounding Sites DB4 and DB5.

Duplicate samples were collected at eight sites for Polymerase Chain Reaction analysis to determine if there was a chronic source of human sewage to the Lower San Diego River from these force mains. Samples were collected in the vicinity of the pipe crossings as well as upstream and downstream. Upstream samples were collected at Sunset Cliffs Blvd. Bridge and at the base of Outfalls 13 and 14. All 18 samples were identified with fecal contamination. However, only 1 of these 18 samples had a weak human fecal signature (5.5%). This sample was collected along the northern region of the beach, in the vicinity of DB5. The two lab control blanks did not have a fecal contamination signature. Based on these results, it was determined that the force mains are a highly unlikely contributor of bacterial contamination to the River and subsequently to Dog Beach.

# Ocean Beach and Mission Beach


Ocean Beach extends from the small jetty at the south end of Dog Beach to Sunset Cliffs south of Ocean Beach Pier and is part of the City of San Diego's Ocean Beach Park. Mission Beach is located north of the Mission Bay Channel and extends north from the jetty until it merges with Pacific Beach. The west-facing Ocean and Mission Beaches are wide sandy beaches providing various outdoor recreational activities, including surfing, swimming, sunbathing, jogging and picnics. Both beaches are popular tourist destinations.

This project area is the location of four sampling stations primarily selected to monitor the effects on water quality up and down current from the San Diego River mouth (Table 10-1).

**Table 10-1. Site description and geographic coordinates.**

| Beach Site # | Site Description | Lat[1] | Long[1] |
|---|---|---|---|
| MB1 | Mission Beach at the foot of Capistrano Place | 32° 45.813' | 117° 15.178' |
| MB2 | Mission Beach at the foot of San Gabriel Place | 32° 45.938' | 117° 15.166' |
| OB1 | Ocean Beach between the Pier and Narragansett Ave | NA | NA |
| OB2 | Ocean Beach at the foot of Saratoga Ave. | NA | NA |
| OB3 | At the foot of Brighton Avenue | 32° 45.142' | 117° 15.155' |
| OB4 | Mid-way between the Brighton Avenue and the Dog Beach jetty | 32° 45.195' | 117°15.155' |

[1] GPS coordinates are in Degrees Decimal Minute format (DD MM.MMMM), NAD 83.

## 10.1 Water Quality and Potential Sources of Impairment by Site

The monitoring sites on Mission Beach and Ocean Beach serve two primary purposes:

1. Evaluate water quality and determine sources of impairment, including San Diego River as a potential source
2. Assess the effect on water quality from sand grooming and sand berm spreading in the spring

The first rounds of sampling were performed to evaluate overall sources and the San Diego River with later rounds specifically targeted at assessing sand berm spreading which took place on April 3 and 4, 2003 at Ocean Beach. Sand management practices are described in Sections 10.2.3 and 10.2.4 below.

### 10.1.1 Mission Beach 1 (MB1)

**Figure 10-1. Mission Beach looking north.**

Site Description

This monitoring site was located north of the River mouth and Mission Bay Channel (Figure 10-1). The Mission Beach 1 (MB1) site was considered up-current of the River influence due to predominating southern currents. This site was designated by the County of San Diego Department of Environmental Health (DEH) as an AB411 monitoring station. Site Mission Beach (MB1) was located at the foot of Capistrano Place (Figure 10-2).

Water Quality Results and Potential Sources

The Mission Bay 1 site was sampled 8 times on 4 days. The four initial rounds of testing were performed on December 2, 2002, March 27 and 28, 2003 and April 1, 2003. Bacterial concentrations ranged from non-detect for all three indicators to 20 MPN/100 mL for total coliform, 20 MPN/100 mL for fecal coliform and 20 MPN/100 mL for *Enterococcus*, as shown in Table 10-2. At this site, the three bacterial indicators were non-detectable in 15 out of 24 (62.5%) of the test results. Appendix B presents all sample results in tabular and graphical format.

**Table 10-2. Bacterial indicator results for Mission Beach 1 (MB1).**

| Parameter | Dates | Range (MPN/100 mL) |
|---|---|---|
| Total coliform | December 2, 2002 – April 1, 2003 | <20 - 20 |
| Fecal coliform | December 2, 2002 – April 1, 2003 | <20 - 20 |
| *Enterococcus* | December 2, 2002 – April 1, 2003 | <10-20 |

This site did not exceed AB411 criteria during the four days it was sampled. Additional information on AB411 criteria are shown in Table 10-3.

**Table 10-3. AB411 exceedances summary chart for Mission Beach 1 (MB1).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| MB1 | No. of Samples | 8 | 8 | 8 |
| | No. of Tests Exceeding AB411 criteria | 0 (0%) | 0 (0%) | 0 (00%) |
| | No. of Samples Exceeding Any AB411 criteria | 0 (0%) | | |
| | No. of Sample Days | 4 | | |
| | No. of Days Exceeding AB411 criteria | 0 (0%) | | |

### *10.1.2 Mission Beach 2 (MB2)*

<u>Site Description</u>

The Mission Beach 2 (MB2) site was located north of Mission Beach 1 (MB1) at the foot of San Gabriel Place (Figure 10-2). Similar to the Mission Beach 1 (MB1), the Mission Beach 2 (MB2) site tended to be outside of the influence of River discharge due to predominating southern currents. This site was not monitored by DEH.


**Figure 10-2. Sampling sites MB1, MB2, OB1, OB2, OB3, OB4.**

<u>Water Quality Results and Potential Sources</u>

The Mission Beach 2 (MB2) site was sampled 8 times on four days. The four initial rounds of testing were performed on December 2, 2002, March 27 and 28, 2003 and April 1, 2003. Bacterial concentrations ranged from non-detect for all three indicators to 80 MPN/100 mL for total coliform, 80 MPN/100 mL for fecal coliform and 10 MPN/100 mL for *Enterococcus*, as shown in Table 10-4. At this site, the three bacterial indicators were non-detect in 18 out of 24 (75%) of the test results. Appendix B presents all sample results in tabular and graphical format.

**Table 10-4. Bacterial indicator results for Mission Beach 2 (MB2).**

| Parameter | Dates | Range (MPN/100 mL) |
|---|---|---|
| Total coliform | December 2, 2002 – April 1, 2003 | <20 – 80 |
| Fecal coliform | December 2, 2002 – April 1, 2003 | <20 – 80 |
| *Enterococcus* | December 2, 2002 – April 1, 2003 | <10-10 |

This site did not exceed AB411 criteria during the four days it was sampled. Additional information on AB411 criteria is shown in Table 10-5.

**Table 10-5. AB411 exceedances summary chart for Mission Bay 2 (MB2).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| MB2 | No. of Samples | 8 | 8 | 8 |
| | No. of Tests Exceeding AB411 criteria | 0 (0%) | 0 (0%) | 0 (00%) |
| | No. of Samples Exceeding Any AB411 criteria | 0 (0%) | | |
| | No. of Sample Days | 4 | | |
| | No. of Days Exceeding AB411 criteria | 0 (0%) | | |

### *10.1.3 Ocean Beach 1 (OB1)*

Site Description

This monitoring location was designated by the DEH as an AB411 site. The Ocean Beach 1 (OB1) site was located south of the Ocean Beach Pier (Figure 10-2). Just south of this station, the beach ends at the base of Sunset Cliffs. With increasing distance north of the cliffs, the beach becomes wider, with a seawall separating the beach from a paved parking lot.

Water Quality Results and Potential Sources

One initial round of testing was performed on December 2, 2002 at the Ocean Beach 1 (OB1). Bacterial concentrations were 70 MPN/100 mL for total coliform, 40 MPN/100 mL for fecal coliform and 20 MPN/100 mL for *Enterococcus*, as shown in Table 10-6. At this site, all of the three bacterial indicators were above the non-detectable limit. Appendix B presents all sample results in tabular and graphical format.

**Table 10-6. Bacterial indicator results for Ocean Beach 1 (OB1).**

| Parameter | Dates | Result (MPN/100 mL) |
|---|---|---|
| Total coliform | December 2, 2002 | 70 |
| Fecal coliform | December 2, 2002 | 40 |
| *Enterococcus* | December 2, 2002 | 20 |

This site did not exceed AB411 criteria on the day it was sampled. Additional information on AB411 criteria is shown in Table 10-7.

**Table 10-7. AB411 exceedances summary chart for Ocean Beach 1 (OB1).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| OB1 | No. of Samples | 1 | 1 | 1 |
| | No. of Tests Exceeding AB411 criteria | 0 (0%) | 0 (0%) | 0 (00%) |
| | No. of Samples Exceeding Any AB411 criteria | 0 (0%) | | |
| | No. of Sample Days | 1 | | |
| | No. of Days Exceeding AB411 criteria | 0 (0%) | | |

### *10.1.4 Ocean Beach 2 (OB2)*

Site Description

This monitoring site was located at the base of Saratoga Avenue just north of the lifeguard tower and south of Dog Beach (Figure 10-2). The beach was wider than at the Ocean Beach 1 (OB1) site, and the seawall ended in this area with a grass lawn behind the beach.

Water Quality Results and Potential Sources

One initial round of testing was performed on December 2, 2002 at the Ocean Beach (OB2) site. Bacterial concentrations were 40 MPN/100 mL for total coliform, 20 MPN/100 mL for fecal coliform and non-detect for *Enterococcus*, as shown in Table 10-8. Appendix B presents all sample results in tabular and graphical format. This site did not exceed AB411 criteria during the day it was sampled.

**Table 10-8. Bacterial indicator results for Ocean Beach 2 (OB2).**

| Parameter | Dates | Result (MPN/100 mL) |
|---|---|---|
| Total coliform | December 2, 2002 | 40 |
| Fecal coliform | December 2, 2002 | 20 |
| *Enterococcus* | December 2, 2002 | <10 |

### *10.1.5 Ocean Beach 3 (OB3)*

Site Description

The Ocean Beach 3 (OB3) site was located at the base of Brighton Avenue, approximately 100 feet north of the Ocean Beach comfort station (Figure 10-2). The sampling site was located approximately 100 feet north of Little Jetty. This station was sampled during the Sand Berm Spreading Studies.

Water Quality Results and Potential Sources

The Ocean Beach 3 (OB3) was sampled 13 times over 5 days. The five initial rounds of testing were performed on March 27 and 28, 2003, April 1, 2003, and April 3 and 4, 2003. Bacterial concentrations ranged from non-detect for all three indicators to 5,000 MPN/100 mL for total coliform, 2,300 MPN/100 mL for fecal coliform and 500 MPN/100 mL for *Enterococcus*, as shown in Table 10-9. At this site, the three bacterial indicators were non-detect in 6 out of 39 (15.4%) of the test results. Appendix B presents all sample results in tabular and graphical format.

**Table 10-9. Bacterial indicator results for Ocean Beach 3 (OB3).**

| Parameter | Dates | Range (MPN/100 mL) |
|---|---|---|
| Total coliform | March 27, 2003 - April 4, 2003 | <20 - 5000 |
| Fecal coliform | March 27, 2003 - April 4, 2003 | <20 - 2300 |
| *Enterococcus* | March 27, 2003 - April 4, 2003 | <10 - 500 |

This site did exceed AB411 criteria during three of the five days it was sampled. Of the 13 samples, 23.1% (3 of 13) had bacterial concentrations that would have exceeded AB411 standards. Additional information on AB411 criteria is shown in Table 10-10.

**Table 10-10. AB411 exceedances summary chart for Ocean Beach 3 (OB3).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| OB3 | No. of Samples | 13 | 13 | 13 |
| | No. of Tests Exceeding AB411 criteria | 1 (7.7%) | 1 (7.7%) | 2 (15.4%) |
| | No. of Samples Exceeding Any AB411 criteria | 3 (23.1%) | | |
| | No. of Sample Days | 5 | | |
| | No. of Days Exceeding AB411 criteria | 3 (60%) | | |

### *10.1.6 Ocean Beach 4 (OB4)*

Site Description

Ocean Beach 4 (OB4) site (Figure 10-2) was located approximately 100 feet south of middle jetty (Dog Beach jetty). This site typically had a steep beach face with a wide flat back beach area used for sunbathing, picnics and volleyball.

Water Quality Results and Potential Sources

The Ocean Beach 4 (OB4) site was sampled 13 times over 5 days. The five initial rounds of testing were performed on March 27 and 28, 2003, April 1, 2003, and April 3 and 4, 2003. Bacterial concentrations ranged from non-detect for all three indicators to 8,000 MPN/100 mL for total coliform, 5,000 MPN/100 mL for fecal coliform and 230 MPN/100 mL for *Enterococcus*, as shown in Table 10-11. At this site, the three bacterial indicators were non-detect in 8 out of 39 (20.5%) of the test results. Appendix B presents all sample results in tabular and graphical format.

**Table 10-11. Bacterial indicator results for Ocean Beach 4 (OB4).**

| Parameter | Dates | Range (MPN/100 mL) |
|---|---|---|
| Total coliform | March 27, 2003 - April 4, 2003 | <20 – 8,000 |
| Fecal coliform | March 27, 2003 - April 4, 2003 | <20 – 5,000 |
| *Enterococcus* | March 27, 2003 - April 4, 2003 | <10-230 |

This site did exceed AB411 criteria during two of the five days it was sampled. Of the 13 samples, 3 of 13 (23.1%) had bacterial concentrations that would have exceeded AB411 standards. Additional information on AB411 criteria is shown in Table 10-12.

**Table 10-12. AB411 exceedances summary chart for Ocean Beach 4 (OB4).**

| Site | | Total Coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|---|
| OB4 | No. of Samples | 13 | 13 | 13 |
| | No. of Tests Exceeding AB411 criteria | 2 (15.4%) | 2 (15.4%) | 2 (15.4%) |
| | No. of Samples Exceeding Any AB411 criteria | 3 (23.1%) | | |
| | No. of Sample Days | 5 | | |
| | No. of Days Exceeding AB411 criteria | 2 (40%) | | |

## 10.2 Ocean Beach Operation and Maintenance Activities

Operational and maintenance activities, in the area that extends from the mouth of the River to Ocean Beach 1 (OB1 at the foot of Narragansett Avenue) including Dog Beach, were investigations by interviewing City of San Diego staff from several departments.

### 10.2.1 Sand grooming

**Figure 10-3. Sand grooming.**

Sand grooming is performed throughout the year on a rotating schedule for all city beaches. The practice at Ocean Beach is to sift or rake the sand to remove trash and debris primarily above the high tide mark. Heavier equipment is used to remove eel grass and kelp from the beach (below the high tide mark) (Figure 10-3). The sand removed from the beach and organic material is taken to nearby Fiesta Island for drying and storage. At Dog Beach the sand is screened or raked approximately every 7 to 10 days in the summer and twice per month in the winter (weather permitting). At Dog Beach the kelp and eel grass are not generally removed from the open beaches. If the organic material is removed it is placed as supplemental fill material on the north side of the jetty (that separates Dog Beach and Ocean Beach).

### 10.2.2 Sand Berms

**Figure 10-4. Sand berms on Ocean Beach – North of Pier.**

It was noted that sand berms have been placed on the beach starting at the jetty just south of Dog Beach to Ocean Beach Pier (Figure 10-4). The berms were built by the City to protect property from flooding as a result of winter storms. The berms are placed in most City beaches in the early winter and are subsequently spread-out in the spring, if they still have form. Berms are composed of sand or a combination of sand and kelp and/or eel grass. The sand is managed at Fiesta Island where the different beach sands are kept segregated in order to return them to the beach from which they originated. Kelp and eel grass are used to add stability to the berms. The kelp and eel grass are air dried at Fiesta Island where they are later blended with sand to prepare the composite material for the winter berms.

The berms at Ocean Beach located on the northern end between the jetty and Brighton Ave. were generally composed of sand only or sand and a light amount of kelp. The berms on the southern end (south of Brighton Ave.) were generally composed of sand and kelp.

### *10.2.3 Pre- and Post- Sand Berm Spreading Bacteria Sampling*

Ocean water samples were collected at Mission Beach (MB1 and MB2) and Ocean Beach (OB1, OB2, OB3 and OB4) in March and April 2003 that correspond to the period prior to sand berm spreading. On December 2, 2002 at OB1 and OB2 field notes indicated that the berms were under construction using bulldozers. Post- sand berm spreading sampling was performed on April 3 and 4, 2003 at OB3 and OB4.

Simultaneously with sampling at Ocean Beach, samples were collected at Dog Beach (DB1, DB2 and DB4) to identify any effects on water quality from the spreading of the sand berms at Ocean Beach. Sampling was performed post- sand berm spreading twice on April 3, 2003 and once on April 4, 2003 (Figure 10-5). Dog Beach does not have constructed sand berms).

Ocean water sampling techniques used during this focused study were the same as used in all other studies (Appendix C – Materials and Methods).

**Figure 10-5. Sand berm spreading at Ocean Beach (April 2003).**

### *10.2.4 Pre- and Post- Sand Berm Spreading Bacteria Results*

A total of 54 samples were collected on three dates (March 27 and 28, and April 1, 2003) prior to berm spreading. The data ranges are summarized in Table 10-13 and by station for all three indicators. Of the 54 samples tested for all three bacterial indicators only 10 out of 162 (6.2%) tests exceedances AB411 criteria. Appendix B presents all sample results in tabular and graphical format discussed in this section.

**Table 10-13. Pre- sand berm spreading bacteria data ranges in MPN/100 mL (March-April 2003).**

| Parameter | Total coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|
| MB 1 | <20 – 20 | <20 - 20 | <10 – 10 |
| MB 2 | <20 – 80 | < 20 - 80 | < 10 -20 |
| DB1 | <20 – 300 | <20 - 170 | <10 – 41 |
| DB2 | <20 – 1,300 | < 20 – 1,300 | < 20 – 110 |
| DB4 | <20 – 2,300 | < 20 – 1,400 | <10 – 657 |
| OB3 | <20 - 170 | <20 - 170 | <10 – 109 |
| OB 4 | <20 - 230 | < 20 - 230 | < 10 – 63 |

A total of 25 post- sand berm spreading samples were collected on April 3 and 4, 2003 as summarized by range of data results in Table 10-14 below. The number of exceedances of AB411 criteria for all three bacterial indicators was 18 out of 75 (24%).

**Table 10-14. Post- sand berm spreading data ranges (March-April 2003).**

| Site | Total coliform | Fecal Coliform | *Enterococcus* |
|---|---|---|---|
| MB 1[a] | NA | NA | NA |
| MB 2[a] | NA | NA | NA |
| DB1 | 130 – 11,000 | 80 – 8,000 | 20 – 80 |
| DB2 | 80 – 8,000 | 40 – 3,000 | <20 – 110 |
| DB4 | 300 – 5,000 | 130 – 2,300 | 40 – 130 |
| OB3 | 20 – 5,000 | <20 – 2,300 | <20 – 500 |
| OB 4 | 20 – 8,000 | < 20 – 5,000 | 40 – 230 |

(a) Mission Beach was not sampled since sand berms were not spread during the time of this study.

An ANOVA test was utilized to determine if there was a significant difference between samples collected pre- and post- sand berm spreading. The results for samples collected at Ocean Beach show all three bacterial indicator concentrations were significantly higher after the sand berms were spread when compared to the data collected before spreading (Figure 10-6). Similarly, bacterial levels at Dog Beach increased following sand berm spreading at Ocean Beach. (Table 10-15). This confirms that the mixture of kelp and sand used to build the sand berms is a source of bacteria to the water column at Ocean Beach and as evident during this study, potentially to Dog Beach as well. AB411 criteria were exceeded by 6% of all pre-sand berm samples compared to 24% of all post-sand berm samples.

**Table 10-15. Geometric means for pre- and post- spreading, Ocean Beach and Dog Beach combined.**

| Bacterial Indicator | Pre- Sand Berm Spreading | Post- Sand Berm Spreading |
|---|---|---|
| Total coliform | 1.9186 | 2.5798 |
| Fecal coliform | 1.8375 | 2.3778 |
| *Enterococcus* | 1.2847 | 1.7589 |

To confirm sand berm spreading activities at Ocean Beach could potentially impact Dog Beach, additional analyses were performed that compared samples collected at the two beaches. Pre-sand berm spreading samples collected at Ocean Beach were not significantly different than pre-sand berm spreading samples collected at Dog Beach. Samples collected at both beaches after sand berm spreading occurred also had comparable means. This suggests that both beaches were influenced by the same source of bacteria, in this case, contamination as a result of sand berm spreading.

**Figure 10-6. Warning posted at Ocean Beach after sand berm spreading (April 2003).**

The data for fecal coliform both pre- and post- sand berm spreading is shown in Figure 10-7. The data are plotted showing the bacteria concentration on the Y axis (in log scale) and dates on the X axis. The blue line shows the tides during the study period. It should be noted that in most instances the higher bacteria levels in water samples is found when the high tide occurs and washes the kelp/sand that is the source of the bacteria. As discussed in Section 9, kelp is a source of bacteria and the results found from those studies are very likely applicable to sand berm construction using kelp as a binder.

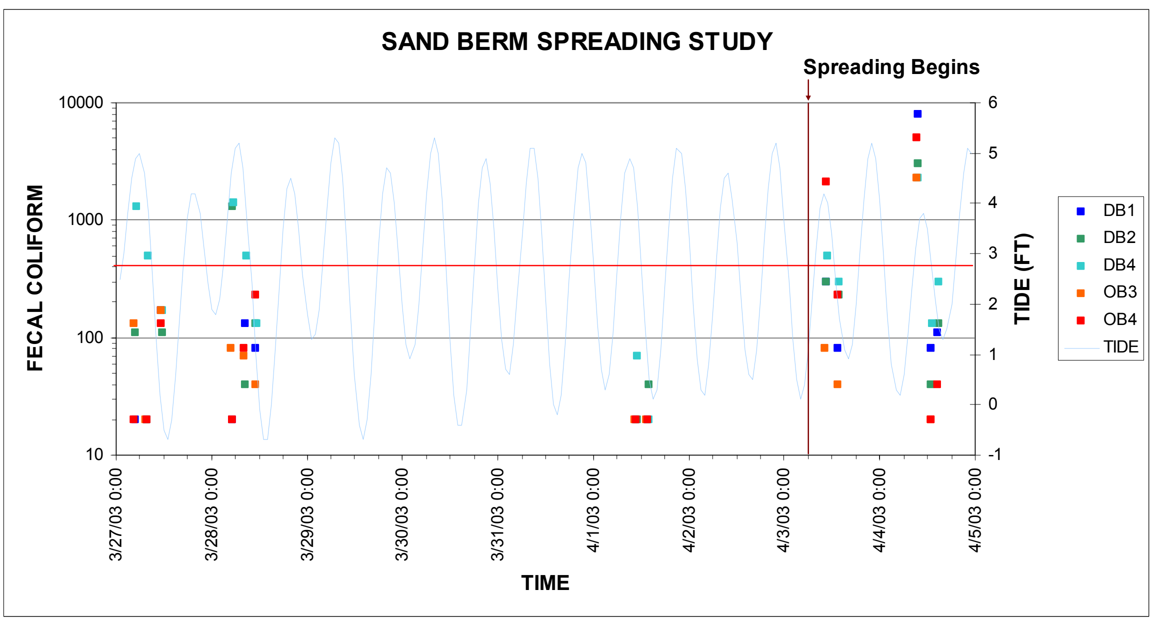



**Figure 10-7. Pre- and post- sand berm spreading data for fecal coliform.**

### *10.2.5 Ocean Beach Comfort Station*

The Ocean Beach comfort station is located on the southwest corner of the intersection of Spray Street and Brighton Avenue. The comfort station is equipped with shower and toilet facilities.

City staff interviewed about the operation and maintenance of the facility provided the following details:

- Facilities are cleaned daily between April and October (usually in the afternoon)
- In the winter (November through March) the frequency of cleaning varies with use between 3 to 4 times per week.
- The external showers drain to a sand interceptor designed to settle the fine sand out and allow clearer wastewater to go down the facility's sewer lateral
- The sand interceptor has reduce the number of sewer overflows and maintenance of the lateral significantly

On August 1, 2003 a close circuit TV inspection of the sanitary sewer lateral was performed to verify its condition. The survey was performed starting at the clean-out and ended at the manhole located at a distance of approximately 139 feet. The general condition of the lateral was good with evidence of repairs. The line is cast iron along the first 38 feet and then vitrified concrete pipe. A small hole was noted at approximately 12 o'clock (the top of the pipe) at 98 feet, but is not considered a concern.

The comfort station does not appear to be a factor in the study area. It is located a distance from the Pacific Ocean and operation and maintenance practices are appropriate.

# Summary of Findings/Discussion

## 11.1 Chronic Inputs

Together, the initial River segment source identification performed in October 2002 and the chronic input investigation surveys performed Spring 2003 through Summer 2003 showed that bacterial concentrations had variable concentrations and in specific locales were elevated by at least an order of magnitude compared to stations upstream and downstream.

A review of the geometric means by site throughout the River showed the following:

- The total coliform concentrations in fresh water were greater (typically 1 order of magnitude) than those in saline water.
- The fecal coliform concentrations varied by site, however, it appears that potential chronic sources in the upper portion of the River did not impact water quality at Dog Beach, as evident in the low values observed behind the Mission Valley YMCA.
- *Enterococcus* concentrations were generally lower throughout the upper portion of the River, except in the vicinity of the Fashion Valley and the Riverwalk Golf Course. *Enterococcus* levels increased at Dog Beach.
- All three bacterial indicators for samples collected at the Sunset Cliffs Blvd. Bridge were low relative to Dog Beach while samples collected at Outfalls 13 and 14 were high relative to Dog Beach. This suggests that water quality impairments at Dog Beach were less influenced by the River during dry weather and more influenced by discharge from Outfalls 13 and 14 and/or localized sources.

There appear to be three primary areas of chronic bacteria inputs to the River from anthropogenic sources. First, an unidentified source in Fashion Valley was contributing to elevated levels observed at Fashion Valley Road. The consistently high concentrations observed here suggest this may have been from infrastructure, although the high concentration of homeless and/or wildlife may also contribute to levels documented. The second area was at the discharge point for Pump Station D, just east of Interstate 5. Pump Station D was the largest station investigated and routinely pumps effluent to the River. The third is from Outfalls 13 and 14 located at the west end of Robb Field. These storm drains serve the majority of the community of Ocean Beach.

Of the three sources from infrastructure, inputs from Outfalls 13 and 14 had the greatest potential to influence water quality at Dog Beach. An investigation into the current patterns on an ebbing tide confirmed that discharge from Outfalls 13 and 14 would be transported around the mudflats and along the northern region of Dog Beach, thereby impacting water quality there. This was also confirmed by sampling performed along a transect parallel to the Sunset Cliffs Blvd. Bridge. Bacterial concentrations observed there were significantly lower than upstream stations, suggesting any potential bacterial contamination being transported downstream by the River was being reduced due to the stressful environmental conditions in the tidal estuary. Deactivation by sunlight and saline water, in combination with the dilution effects of the River discharge entering a larger body of water have been documented to reduce bacterial concentrations and growth in previously published literature.

It should be noted, however, that increased river flow following rain storm events did influence water quality at Dog Beach. This was evident in the historical data review and sampling conducted within 72 hours of a storm event on December 2, 2002. As this project was focused on finding dry weather chronic sources that may impact water quality at Dog Beach, no work was performed to determine the fate and transport of bacteria at Dog Beach following a storm event.

Source identification studies were performed in areas with consistently higher bacterial contamination. Dog Beach was one area that continued to have elevated levels of bacteria, even though it appeared that the tidal estuary upstream provided the space and time for mechanisms to reduce inputs from the River. Therefore, two investigations of municipal sanitary sewer systems in the vicinity of Dog Beach were conducted. First, CCTV of the sewer lines originating at the comfort station located at Ocean Beach was performed. These results showed that the sewer lines were clean and in excellent repair. Second, samples were collected for PCR analyses upstream and downstream of two sanitary sewer system force mains. These results showed no direct human sewage contamination, confirming that the force mains were not a source.

## 11.2 Dog Beach

Based on results from investigations into potential chronic inputs to the River, the focus of the study was adapted to investigate local sources of bacterial contamination. The most obvious source of contamination was from the dogs and the abundance of migratory shorebirds congregating on the mudflats. Surveys were then developed to investigate a variety of sources of transport mechanisms. The potential water quality contamination correlated to dog feces concentrations was investigated. Sediment samples from shorebird habitat were collected to determine the magnitude of bacteria loading from birds. Bacterial contamination in relationship to tide height was evaluated. Focused studies around high tide were performed to confirm trends seen during 24-hour sampling studies. Wrack samples were collected to determine the magnitude of loading from decomposing marine vegetation.

### 11.2.1 Sediment

Based on a single sampling day, samples of sediment from the mudflats and the eastern region of Dog Beach did not have significant bacterial contamination that could provide the water quality impairments observed. Sediment samples from the mudflats had total and fecal coliform concentrations ranging from non-detect to 36 MPN/gram of dry weight and *Enterococcus* concentrations ranging from 14 to 226 MPN/gram of dry weight. Similar values were seen in sediment from Dog Beach. Total and fecal coliform concentrations ranged from non-detect to 100 MPN/gram of dry weight and *Enterococcus* concentrations ranged from 2 to 67 MPN/gram of dry weight. Although the reference site sample did not have any of the three bacterial indicators detected, the results did not indicate the sediment was the primary source of bacterial contamination at Dog Beach.

### *11.2.2 Tidal Influence*

Although statistical analyses were unable to confidently correlate a relationship between tidal height or stage with bacterial concentrations, the data collected during this study and results from studies performed elsewhere suggested there was a pattern. Bacterial concentrations appeared to elevate following the high-high tide. For all the 24-hour sampling studies, the extreme high tide occurred in the evening hours, so the confounding variable of the presence or absence of sunlight may have influenced these results. A follow-up study, performed once, suggested that the lack of sunlight was not a contributing factor to the rising bacterial levels.

### *11.2.3 High Tide Washing*

The results of the Tidal Influence (24-hour) Studies suggested that bacterial contamination was related to high tides so focused sampling was performed around the high tide. This study was designed to determine relationships between areas with high versus low concentrations of dog feces, to determine relationships between regions of the beach and to determine relationships of sampling performed prior to, during and after the high tide. An analysis of the results showed that there was no significant difference between areas with or without apparent dog feces, and that the eastern and northern regions of the beach were similar as well. The DEH AB411 sampling site tended to have significantly lower values than elsewhere on the beach. This may be a result of this station's surf zone environment compared to the more estuarine environment of the other sites. Additionally, analyses showed that the samples collected approximately three hours prior to the high tide had bacterial concentrations that were significantly lower than samples collected at the peak high tide. The samples collected following the high tide tended to have bacterial concentrations lower than those collected at the peak high tide and higher than those collected prior to the high tide, however, neither relationship was significantly different. The slightly elevated post-high tide bacterial concentrations may be a caused by the lack of sunlight (which acts as a bactericide), enabling the bacteria to survive longer in the saline water.

### *11.2.4 Kelp*

Samples of the kelp and eelgrass that comprise the wrack line (deposited marine vegetation and debris on the beach found at the extent of the last high tide) were found to be a significant source of bacterial contamination. In samples of decomposing marine vegetation, total and fecal coliform concentrations were as high a 144,527 MPN/gram of vegetation and *Enterococcus* concentrations were as high as 40,628 MPN/gram of vegetation. In contrast, samples of freshly deposited marine vegetation rarely exceeded detection limits for all three bacterial indicators. The methods used to perform the analysis simulated the washing effects of the wrack line in the field. This suggests that the wrack line was a primary source of water quality impairments at Dog Beach. However, investigations into the mechanisms that produced the elevated bacterial levels were not performed. Therefore, it was not determined whether these results were a direct result of simple decomposition, rapid regrowth of bacteria in an environment preferred by the indicator bacteria (assumed to be the most likely case) and/or direct deposition from wildlife (dogs, birds, insects).

### *11.2.5 Trash cans*

Trash cans are located near the parking lots or streets. Frequency of pick-up is daily in the summer and lesser in the winter. The number of cans and the frequency of removal of the trash are reduced in the winter, but appear to be adequate. At Dog Beach, trash cans are located near the parking lot, walkways, and at midpoints between the parking lot and the water's edge. The only area that does not have trash receptacles is the northeast end of Dog Beach.

### *11.2.6 Dog Waste Bags*

Dog waste bags are abundant on Dog Beach and properly stocked. Dog waste bags are not provided on the northeast end of Dog Beach. All signs describing the requirement to use the bags are clear and legible (Figure 10-8).

**Figure 11-1. Dog waste signs.**

## 11.3 Ocean Beach

### *11.3.1 Sand Berms*

The results for all three bacterial indicators had higher levels after the sand berms were spread as compared to the data collected before spreading. Statistical analyses did not show a significant difference between samples collected at Ocean Beach versus Dog Beach. These results suggest that the mixture of kelp and sand used to build the sand berms was a source of bacteria to the water column at Ocean Beach and Dog Beach when the current flows south to north along the shoreline.

# Recommendations

Recommendations identified during the course of this project that could be implemented to reduce bacteria sources to the River or Dog Beach were presented to City staff during biweekly update meetings. As a result, action was taken by the City when the recommendations could be implemented in an expeditious manner. In addition, other recommendations were made following the completion of several of the project's studies. This section summarizes the recommendations made to the City during Phase I. Phase II recommendations are identified as appropriate.

## 12.1 Sanitary Sewer Infrastructure

The sanitary sewer infrastructure surrounding the study area was not found to be a chronic source of bacterial contamination to the River, Dog Beach and Ocean Beach. Beach closures due to sanitary sewer overflows and spills have been reduced in the last couple of years. As noted above, the sewer infrastructure should continue to be a priority for the City in order to sustain the reductions in sewer overflows, pipeline failures, etc.

The City is continuing sanitary sewer infrastructure maintenance and replacement in support of water quality improvement goals in the receiving waters (San Diego River and tributaries, and surrounding beaches).

## 12.2 Storm Drain System Infrastructure

Significant changes and improvements have been undertaken by the City in operation and maintenance practices of the storm drain system over the last few years. As a result, improvements in water quality in San Diego River and surrounding beaches have resulted in a reduction of health warning postings and closures. The City is continuing to evaluate water quality, resulting in improvements in operational and maintenance practices. As new information and data on best management practices becomes available, the City may find alternatives to existing practices that are beneficial to implement.

Improvements in storm drain system practices that were identified during this project are as follows:

1. Various outfall gates were identified has failing to close or seal and requiring replacement. Priority should be placed on the replacement of gates for Outfalls 13 and 14. The evaluation of gate replacement should include alternatives to the Tideflex system which become clogged with sediment and debris allowing tidal intrusion of seawater into the storm drain system. Outfall 8 also requires gate replacement.

2. Outfalls 13 and 14 require urban runoff diversion systems that are more reliable and effective in minimizing the impacts on water quality in the River and at Dog Beach. The diversion structures in the storm drain line need to be surveyed and brought up to the appropriate elevation that will allow the nuisance water (urban runoff) coming down the line to be properly diverted into the Sewer System. This will require the construction of diversion structures with a maximum elevation that is higher that the highest tide that occurs at the outfall through the calendar year. Considerations for this repair must also look at how the added intrusion will affect the normal flow of storm water in the system during rainfall periods. The intrusion may cause unacceptable turbulence and or obstruction to the storm drain thus restricting flow to the point that the system would not be able to convey its entire medium during a rain event. This can also be accomplished by placing tide valves at the end of the outfalls that will not allow the tide water to regress up into the storm drain pipe during high tide periods inundating the diversion system during storm event. Additional operational and maintenance features should be evaluated as part of the redesign project.

3. Pump Station D bacteria levels during dry weather periods are elevated and contribute to water quality degradation in San Diego River. Reductions in bacteria levels from Pump Station D are recommended, as funding becomes available, by evaluating the feasibility of:
   - ♦ Diversion to the sanitary sewer during dry weather periods;
   - ♦ Treatment options for Pump Station D effluent;
   - ♦ Installing energy dissipation structure(s) at the outfall.

4. The diversion system should be inspected and cleaned at a frequency that improves urban runoff diversion during dry weather, especially during the high use period (spring through fall). The diversion of urban runoff during the summer season can significantly reduce bacteria levels that reach Dog Beach and Ocean Beach, and reduce the number of beach postings and closures. The City should develop a program to visually inspect each diversion structure installed to protect San Diego River from urban runoff. The inspection program should lead to a prioritized maintenance and repair schedule that minimizes the downtime of the diversion system.

5. The City collects information on the diversion system from the Metropolitan Wastewater Division, however, this information does not always accurately represent the system status (i.e.; malfunction) information. Continued cooperation and joint management of the diversion system is highly recommended to ensure it functions as designed. During this project, it was recommended that the City work to develop a process to communicate more specific problem information and approximate down time of the diversion system promptly to the City Storm Water Pollution Prevention Program. Both the Streets Division and the Metropolitan Wastewater Department manage the Mission Bay Sewage Interceptor System which includes San Diego River stations. Joint meetings by the Metropolitan Wastewater Department and Streets Division are held monthly to

review maintenance and operation needs. Continued cooperation and joint management of the system will to ensure system function.

6. Outfall inspection and maintenance to minimize the failure of gates (slide gates, Tideflex, etc.) and reduce seawater intrusion and flushing should be conducted on a more frequent basis. The inspection program should result in prioritized maintenance and repair of faulty gates. Maintenance should include removal of sediment accumulated at the outfalls that prevents closure of the gates.

## 12.3 Dog Beach Operation and Maintenance

The results of the various studies conducted at Dog Beach suggest that improvements in operation and maintenance practices may result in improvement of water quality by reducing sources of bacterial contamination that lead to beach closures. The following actions were recommended to the City.

1. Continue the current practice of placement of additional trash cans during high season (spring-fall) at Dog Beach. Improve the placement of the trash cans so that they are readily accessible to users throughout the beach and increase the public's compliance with the scoop the poop policy. A map with recommended trash can placement was developed that targets higher use areas as determined by surveys and observations. The City responded to the recommendation by placing additional trash cans in June 2003. On Figure 12-1 the red dots show the usual location of trashcans (survey conducted on July 12, 2003). The placement of the trash cans should be strategic to maximize their use. The recommended locations shown on the map (Figure 12-1) with green dots showing the recommended placement locations that should be implemented again for the high season in 2004.

2. The City should increase the number of scoop the poop policy signs and bag dispensers at the north and northeast end of Dog Beach.

3. Maintain public awareness of scoop the poop policy and the negative impact of dog feces on water quality which leads to beach closures. At an appropriate frequency, no less than annually and preferably during the high use season, promote the scoop the poop policy to maintain compliance and reduce water quality impacts from dog feces on the beach. There are a variety of mechanisms to accomplish this including enforcement action.


**Figure 12-1. Recommended trash can placement at Dog Beach during spring-fall.**

## 12.4 Ocean Beach Operation and Maintenance

Numerous observations were made during the project to identify potential bacterial sources and opportunities to improve water quality by changing or improving best management practices at Ocean Beach.

1. Sand berm spreading in the spring should be managed (scheduled) to minimize spreading into the water and wave flushing immediately after spreading. Sand berms should be spread during neap tides to minimize wave action flushing. Newly spread sand should not be pushed into the water in order to allow it to be exposed to sunlight which acts as a bactericide. If possible, sand berms should be constructed without the use of kelp or other organic materials that promote the growth or re-growth of bacteria in areas were the risk to public safety from flooding is minimal.

2. Sand grooming should be managed similarly to sand berm spreading to minimize the exposure of freshly groomed sand to high tides or flushing by waves. Freshly groomed sand should be exposed to sunlight prior to wave action flushing.

3. Kelp removal from the beach should be implemented to minimize the exposure of decaying kelp and kelp laden with dog waste to wave flushing. During the high human usage period and AB411 water quality monitoring (April – October) the kelp on Dog Beach should be removed from the beach at a frequency that minimizes the exposure of decaying kelp and kelp with dog waste to high or flood tides. Preferably kelp removal should take place during low tides to maximize effectiveness. Kelp should not be returned to the ocean, but instead disposed permanently (to a landfill) unless a feasible reuse is found (it should not be used to amend sand for winter berms).

4. Comfort station cleaning and sanitary sewer maintenance should be continued. The City has an effective program that maintains the sewer infrastructure from the comfort station in excellent working condition and minimizes sewage overflows. The installation of large underground sand trap to remove sand from the shower wastewater has minimized failures in the sewer lateral from the comfort station. The City will continue to maintain the sand trap and infrastructure in its current configuration.

## 12.5 Phase II Recommendations

1. Design and construct improvements to the gates at Outfalls 13 and 14 to minimize seawater infiltration and tidal flushing of the storm drain.
2. Design and construct a more reliable urban runoff diversion system and storm drain system for Outfalls 13 and 14 that is easier to operate and maintain, and maximized water quality.
3. Remove sediment at bottom of Outfall 8 and replace gate.
4. Design and implement improvements at Pump Station D to reduce bacteria inputs to San Diego River.
5. Verify improvements in water quality after the implementation of the diversion system inspection and maintenance/repair program.
6. Design, implement and manage a sand management program based on the recommendations found during Phase I as a pilot for the region.
7. Verify improvements in water quality after the implementation of Dog Beach operations:
    a. sand berm spreading,
    b. sand grooming,
    c. kelp management,
    d. trash can and bag dispenser placement, signage and policy awareness.

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